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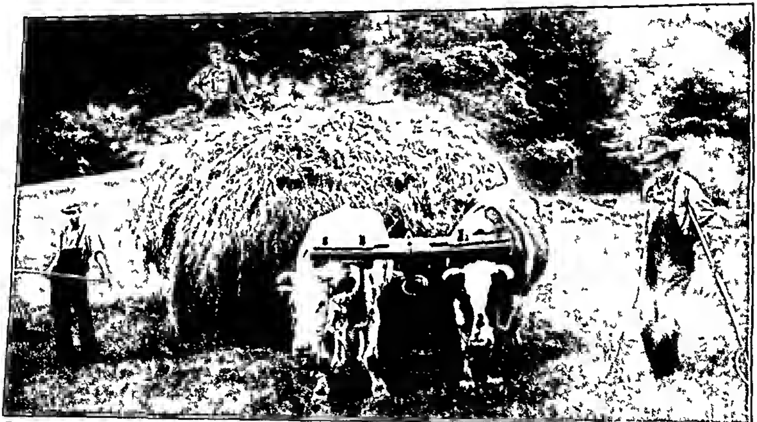
Dairy Cattle

Selection, Feeding, and Management



Dairy cattle contribute to the national welfare by converting much coarse forage into a wholesome and highly nutritious food—milk. This picture represents an era when dairy cattle also furnished power for farm work

Dairy Cattle

Selection, Feeding, and Management

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TO

THE YOUNG MEN AND WOMEN

WHO PLAN AS FARMERS AND HOMEMAKERS

TO ENGAGE IN THE CARE OF THE DAIRY COW,

THE SOURCE OF MANKIND'S MOST

ESSENTIAL FOOD

Preface

Many new developments have taken place within recent years in practically every field of human endeavor. Technological advances have occurred with amazing rapidity. New basic raw materials have been found; new compounds and new products have been prepared; new machines for doing jobs with less labor than formerly have been put into use; and feats which in the past were no more than dreams have become realities.

The advances which have been made in the plant and animal sciences, in agricultural engineering, and in all other fields related to agriculture are commensurate with those which have taken place in nonagricultural fields. It therefore has become imperative that a new edition of *Dairy Cattle* be prepared so that the book will reflect the many new research findings and new practices which have become known or put into use since the Third Edition was issued in 1941. In order that dairy students and dairy farmers may have the benefit of the latest information on the selection, breeding, feeding, and management of dairy cattle, as well as guides to good procedures for the growing of roughages for the dairy herd, the entire book has been rewritten. Many new findings have been incorporated, the subject matter has been expanded, and new tables and illustrations have been prepared.

As this is being written, dairy farmers are faced with severe economic problems because of the competition offered by so-called substitutes for dairy products. These new preparations have cut severely into market outlets for butterfat. Because of these competitive products, it is more necessary than ever before that dairy farmers avail themselves of the most recent information which may help to improve the efficiency of their dairy-farming operations. We pointed out in the 1941 edition of the book (page 440), "Unless dairy farmers adopt measures that will provide for the greatest possible efficiency in production and take an active interest in their markets, it is likely that they can not profitably continue to keep cows for the sale of butterfat. Markets for whole milk, on the other hand, are likely to

offer better returns, although here, too, the highest efficiency in production and the improvements of markets through advertising and other means must be sought. Present economic trends indicate that this warning which subsequent events proved to have been sound is equally applicable to present conditions. We believe that dairy farmers should carefully watch market requirements and actively participate in marketing programs during the years ahead.

In preparing this book our aim has been to point out principles which students and dairy farmers may use as guides rather than to give explicit directions for doing every job. Keeping in mind the fact that new machines, new types of buildings, and new pieces of equipment may alter the manner in which the various operations are carried out. The principles governing good care and management of dairy cattle, however, remain the same as they were at the time the book was first issued in 1926.

We are pleased that so many readers have found the book of value. A special edition was printed for the use of the United States Armed Forces Institute in 1944. It is hoped that the Fourth Edition will also be an aid to students, dairy farmers, and others who desire a guide to the principles governing the selection, breeding, feeding, care, and management of dairy cattle.

Grateful acknowledgment is made to our colleagues who read portions of the manuscript and aided in its revision. Chapter 12, Determining Milk and Butterfat Yields, was reviewed by M. H. Alexander, Associate Professor of Dairy Production. Chapter 16, Preventing Illness in the Dairy Herd, was read by Dr. L. E. Boley, Head of the Department of Veterinary Clinical Medicine. Chapter 19, Factors Affecting Returns from the Dairy Farm, was revised in accordance with suggestions made by Dr. F. J. Reiss, Assistant Professor of Agricultural Economics. Dr. R. S. Stauffer, Associate Professor of Soil Physics, Department of Agronomy, gave material aid in the preparation of Chapter 23, Grassland Farming on Dairy Farms.

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Dairy Farming Is a Great and Abiding Industry

In continental United States each morning and evening 8 million persons on 3,600,000 farms go to some barn, milking parlor, or paddock to milk[1] By this process they remove each day about 368 million pounds of milk from approximately 24 million dairy cows. If this milk were poured into 8-gallon cans, and much of it is, and 50 of these cans were placed in each truck, it would require 106,976 trucks to haul the day's production to market. Upon reaching market this milk is processed into a number of different products by approximately 17,000 different manufacturing establishments.

The production of milk, the processing of it into various manufactured products, and the consumption of milk and milk products by people are closely interlocked. Major changes in any one of these three activities has a definite impact upon the other two. The dairy industry has undergone some basic changes since the early 1940's, but the most significant of these has occurred in the use of milk.

How milk use has changed. As late as 1940, 41.13 per cent of all of the milk produced in the United States was made into butter. Ten years later, only 27.00 per cent of the nation's milk was used in that product. Furthermore, this trend seems still to prevail, for in 1952 the amount of milk used in making butter had dropped to 24.5 per cent.

This change in the use of milk is having an effect upon the industry. It has brought about a shift in use, so that the portion of the nation's output which was formerly allocated to butter, but is not now used for that purpose, has gone into fluid milk for drinking and household purposes, cheese, ice cream, and concentrated and powdered dry milk. The entire nation's output of milk is, therefore, still being utilized. Furthermore, this shift has probably had a favorable influence upon the farm price of this milk because, generally speaking, milk is worth more in these products than it is in butter.

[1] U.S.D.A. Rept.

Table 1 1 Changes in Milk Use from 1940 to 1950

Kind of Product Manufactured	Per Cent of Total 1940	Per Cent of Total 1950
Market milk and cream	41 73	47 40
Butter	41 13	27 00
Cheese	7 20	9 50
Evaporated and condensed milk	5 38	5 60
Ice cream	4 31	5 10
Dried whole milk	0 20	1 20
Dried cream, malted milk	0 05	
All other products		4 20
Total	100	100

It should be mentioned, however, that certain areas, especially those regions that were producing sour cream for buttermaking and where markets for whole milk had not yet been established have been adversely affected Likewise, the owners of many small herds, especially herds of five or less cows, find that their sour cream market is gradually disappearing The net result of the shift in the use of milk will very likely be reflected in somewhat larger dairy herds and in the improvement of the farm quality of milk and cream

The products of the dairy cow are consumed by people In any food producing industry it is important to know how the product is used Dairy products are consumed directly by people With fluid milk, for example, the only processing required is pasteurization[1] to protect health and packaging for convenient distribution In products such as butter, cheese ice cream, condensed or evaporated milk, and powdered milk, greater change is made by the manufacturing process but the products are ultimately eaten by people

This fact is important to the dairy industry because any growth in population adds directly to the market demand The more mouths to feed, other factors remaining the same, assures the dairyman that more milk will be consumed If additional evidence on this point is

[1] Pasteurization is a process whereby a liquid is heated to a temperature high enough to destroy certain types of bacterial organism The process was first discovered by the French scientist Louis Pasteur Pasteurization as now used in the dairy industry involves one or the other of two methods Either milk is heated to a relatively high temperature (160° F) for a short period (15 seconds) or it is held at a relatively lower temperature (143° F) for a much longer period (30 minutes) Neither process exerts any deleterious changes in the chemical or biological value of milk, and both protect the consumer from any possible milk-borne disease

required it is provided by the ratio between population and cows kept for milk production.

Human population and cow population have increased in a similar ratio. At no time for the past 70 years has there been more than 6.6 persons for each dairy cow. Figure 1.1 presents in graphical

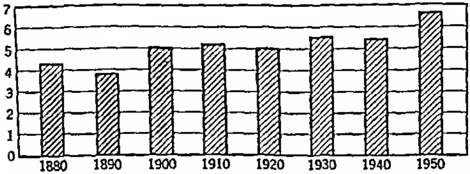

Fig 1.1. Number of persons per cow in continental United States, 1880–1950 (U S Census Reports).

form the number of persons in the United States for each cow that is listed in the census as kept for milk production. It should be noted that during this 70-year span the greatest variation occurred between the census years of 1890 and 1950 The difference between these two periods was 2 6 persons. It ought to be mentioned also that cows in 1950 yielded more milk and fat than did those of 1890; consequently, the amount of milk available per person was, in fact, greater in 1950 than in 1890. Statistics prepared by the United States Department of Agriculture show that there has over the long pull been a definite uptrend in per cow yields of both milk and fat. Table 1.2 shows the nature and degree of this trend.

Table 1.2. Average per Cow Yield of Milk and Fat for All Cows Kept on Farms in United States from 1930 to 1950

Year	Total No. Cows, thousands	Ave. Milk Yield, lb.	Ave. Fat, %	Ave. Butterfat Yield, lb.
1930–34	23,938	4,297	3.93	168.8
1935–39	23,548	4,403	3.95	174.0
1940–44	24,884	4,658	3.97	185.1
1945–49	23,861	4,993	3.98	198.5
1950	22,779	5,292	3.96	209.8
Total gain 1930–1950		784	0.04	33
Ave. annual increase		37.3	0.0019	1.57

An analysis of the data in this table shows (1) that there is variation between years a national drouth can decrease anticipated yields or national programs for greater milk production can add to yields (2) It also shows, and this is probably more significant, that the national level of milk production is increasing at the rate of 35–40 pounds per year and that butterfat yield increases 1 5–1 7

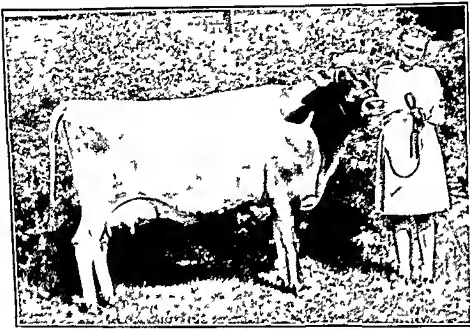

Fig 12 There is always satisfaction in honest achievement This 4 H club girl and her champion young Jersey cow forecast the hope and betoken the abiding nature of the dairy industry

pounds per year (3) It further demonstrates that to increase these values materially beyond the advances indicated would require a resolute and well conceived national program of dairy cattle improvement

The principal business of the dairy farmer is food production The dairy cow is a highly efficient food factory Her udder, technically referred to as the mammary gland, was designed by nature to provide a highly nutritious and easily digested substance to sustain a non-precocious offspring and thereby preserve the race This substance, milk, proved so desirable and valuable as a food for man that he has used it as the basis upon which to build a great enterprise

The dairy cow uses feed efficiently. It is extremely important to the man who lives by the dairy industry, the dairyman, to know that he is identified with an inherently efficient process. This is true in part, because the cow is a ruminant. The mature cow has a chamber or rumen with a huge capacity (often 30 to 40 gallons) in which feed is fermented and agitated in the presence of a battery of microorganisms that can synthesize proteins from simple nitrogenous compounds, such as urea. Non-ruminants cannot do this. Furthermore, this same mechanism (the rumen) can synthesize B-complex vitamins as well as produce various important organic acids. All of this plus the fact that these things can be done from enormous quantities of roughage which many otherwise efficient animals cannot use as effectively.

A second advantage possessed by the dairy cow is that she uses her feed very efficiently. A high-producing dairy cow is able to convert approximately 35 per cent of the energy she consumes in the feed which she eats into the energy of the milk which she produces. Comparatively, this places her almost at the top of all domestic animals in the efficiency with which she produces human food. The pig is slightly more efficient in converting the energy from feed into human food than the dairy cow but to be efficient the pig requires a much higher proportion of grain which makes him less well adapted to roughage consumption and to soil conservation. Generally speaking, nutrients provided in grain cost more than those contained in roughage. Therefore, for economy of production, roughage consumption is highly desirable.

Why is milk so highly valued for human food? In that grand class of animals known as mammalia, to which both man and cattle belong, the young are born highly dependent upon at least one of their parents or other adults of the species. Calves, for example, at birth possess a very small and rudimentary rumen. The calf, therefore, cannot subsist upon roughage which is the natural food of the bovine species. Nature took care of this situation by providing a substance, milk, which is secreted in the greatest amount by the mammary gland of the mother (udder in the cow) soon after the young is born. This substance which is easily digested and highly complete in its nutritional properties has thus by adoption become man's most perfect single food. Perhaps we are not extending the truth too far if we argue that we have the great dairy industry largely because the newborn calf does not have a functioning rumen. Thus we

FIG 1.3 This Brown Swiss Herd now owned by Jake Voegeli Monticello Wis was established by the Voegeli family in 189[illegible] It speaks in a material way for the sturdiness and soundness of the dairy industry

account for the existence of milk we must now deal more fully with its composition and nutritional properties

Milk is nature's most perfect food Since milk was intended by nature to nourish the immature and highly sensitive young many of which are born without teeth it is only natural that it is in liquid form The average gross composition of cow s milk is indicated in Table 1.3

Table 1 3 Composition of the Solids in Cow's Milk

Constituent	Ave Mean		Amount of Variation % High		Low	
Total protein	3 55		6 40		2 07	
1 Casein		3 02		6 29		1 79
2 Albumin		0 53		1 44		0 25
Fat	3 80		10 00		1 20	
Lactose	4 90		6 12		2 11	
Ash	0 71		1 21		0 35	

Milk is somewhat variable in the amount of the different components present in any one sample The extent of the differences indicated in Table 1 3 presents evidence in support of this conclusion However the average analysis of many samples shows *that* milk although a liquid contains approximately 13 per cent dry matter

(nutrient material). This is a higher dry matter content than is found in lettuce (5 per cent), tomatoes (6 per cent), or turnips (9 per cent), which are regarded as solid foods.

The complete nutritional value of milk cannot be stated in terms of a simple chemical analysis. Even the more complete biochemical assay given in Table 1.4 does not tell the entire story of the goodness of or even list all of the nutrients contained in milk.

Table 1.4. *Nutrients Contained in* 1 *Quart of Cow's Milk of Average Composition*

Nutrient	Amount in 1 Qt. Milk	Daily Requirement of an Average-Sized, Moderately Active Man
Protein	35 grams	70 grams
Fat	39 "	...
Sugar (lactose)	49 "	...
Calories	700	3000
Ash (minerals)	7.0 grams	
Calcium	1.2 "	0.8 gram
Phosphorus	1.0 "	1.2 "
Iron	1.0 mg.	12 mg.
Copper	0.1 "	1.0 mg.
Vitamin A	900–1800 I.U.*	5000 I.U.
Vitamin D	5–40 I.U.	400 I.U.
Vitamin C	20 mg.	75 mg.
Thamine	0.4 mg.	1.8 mg.
Riboflavin	2.0 "	27 mg.
Nicotinic acid	0.8 "	18 "
Total solids	130 grams	

* There are certain vitamins, notably A and D, that are greatly influenced by seasonal conditions. When cows are at pasture with plenty of sunshine their milk is relatively high in these vitamins but when barn fed in the winter the vitamin content of the milk is lower.

Certain of the nutrient constituents of milk exercise a greater influence on nutrition than is indicated by the amounts present in the milk itself. For example, when milk protein is present in the digestive tract of a person the protein of potatoes is raised in biological value from 70 to 86 per cent, white bread from 50 to 75 per cent, and corn protein is doubled in value.

The lactose (sugar) of milk is about one-sixth as sweet to the taste as sucrose (cane sugar) and has certain attributes that add value to the nutritional properties of milk. Lactose tends to prevent putrefactive organisms from developing either in the digestive tract or in milk itself. Especially is it of value in preventing putrefaction

in fermented milk drinks such as acidophilus milk, buttermilk, etc. Brain size in the adult and even intelligence is presumed to be correlated to the lactose content of the milk of a species. For example lactose composes 56 per cent of the dry matter of human milk, 36 per cent in the cow, and much less in lower mammalian forms such as the rat, guinea pig, and rabbit.

Milk is a complete food because it contains proteins, vitamins, minerals, and energy (carbohydrates and fats), the four basic nutrient needs. These categories could be matched by other foods but in milk lactose is added to these and all are so perfectly balanced that you have nature's most perfect food.

It should be highly satisfying to a dairyman, or a potential dairyman, to know that he is supplying society with nature's best food and that good cows are highly efficient in its production. These qualities of the industry, together with the equally cogent fact that most persons both young and old are either regular or potential consumers, establish dairying as both a great and abiding industry.

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REVIEW

1. Is milk produced by a few large factory-like units or by a large number of small operators?
2. What is the average daily production of milk on a dairy farm?
3. What dairy product is being replaced by so-called substitutes?
4. How has the ratio between human population and cow population been maintained?
5. Have cows increased or decreased in annual milk production during the last 25 years? What is the annual yearly increase or decrease in milk and fat yields?
6. How efficient is the dairy cow in the production of human food?
7. Discuss the value of milk as a human food.
8. What is lactose? How much is found in milk? What value does it have in milk?
9. What characteristics of the dairy cow and the dairy industry make it probable that dairying may increase in importance in animal agriculture?
10. Discuss the advantages milk has in the human diet.

2

Shall I Become a Dairy Farmer?

Before any serious-minded young person makes a final decision about a career he or she should go in search of the truth about it. Truth is usually measured by acceptance. If a fact or an idea is not challenged as to its validity, it is in time accepted as true. If it is challenged but is successfully substantiated, and people do not lose their confidence in it, it still is held to be the truth. The absolute or complete truth about anything is seldom known. Especially is this true of the sciences, an area in which we are constantly probing for new truths.

Ideas are usually the outgrowth of the organization and classification of facts. Facts, particularly those that relate to agriculture, are located by the use of a technique known as "the experimental method." This method for discovering facts has probably added more to the development of the dairy industry and accounts for more of the progress made in it than has any other contribution. By its use, for example, Babcock discovered a simple test for fat in milk, Pasteur developed the principle of pasteurization, etc. By the application of this procedure we have hybrid corn, soil conservation, milking machines, artificial insemination, and many other epoch-making discoveries. By virtue of these developments dairy farming has become an easier but a more complex occupation.

Every occupation has certain advantages and usually some disadvantages. Before any person making a choice decides that he would like to be a dairyman, he should carefully study the advantages and disadvantages of the occupation.

What are the main advantages associated with dairy farming? More and more emphasis is being given to animal agriculture. This type of agriculture has been developed because it fulfills a need, a need to establish a planned program for resources conservation. Ruminants use grass and roughage with a high degree of effectiveness, because of rumen digestion as was pointed out in Chapter 1.

The dairy cow enjoys the highest efficiency of all ruminants in roughage utilization

The dairy cow is an efficient unit in animal agriculture. As more acres of grass crops are introduced in soil-conservation programs in an effort to reduce both wind and water erosion the need for their conversion into cash becomes more pressing Table 2 1 indicates how effectively a grass sod can reduce water erosion

*Table 2 1 Losses of Soil and Water from Pastures * and from Crops in Rotation, Dixon Springs Experiment Station 1939 1946 (plots 70 ft long with 9% slope)*

Crop	Period mo	Soil Losses per Acre, tons	Run-Off of Rainfall, %
Corn	5	13 5	27 6
Winter wheat	7	10 3	23 5
Lespedeza	First 12	5 7	22 9
Lespedeza	Second 12	0 4	13 0
Pasture *	12	0 1	8 5

* Pasture was treated, seeded to mixture of grasses and legumes and moderately grazed Bluegrass and lespedeza predominated in the stand

In any soil-conservation program preventing erosion and reducing water run off constitutes the first phase of the program The second phase is to find a profitable use for conservation crops Table 2.2 shows the relative efficiency with which different farm animals can use roughage

*Table 2 2 Feed Units * Required to Produce 2600 Calories of Human Food*

Class of Animal	From All Feed	Amount Derived from Grains and Concentrates
Cow (dairy)	9 3	2 3
Cattle (beef)	71 6	15 7
Sheep and lambs	74 5	4 7
Hogs	7 7	7 2
Chickens (eggs)	21 9	20 6
Chickens (meat)	29 9	27 1

* The feed unit is used especially in the Scandinavian countries for measuring the relative value of different feeds The standard in this system is based upon the feeding value of 1 lb of barley The equivalent value of any other feed therefore, is considered to have the same productive capacity as 1 lb of barley

This table confirms the statement made in Chapter 1 that dairy cows are highly efficient in their use of feed Furthermore, it shows that three-fourths of the total nutrients required to produce 2600 calories (approximately the daily requirement for an inactive person of average size) are derived from roughage and only one-fourth is obtained from grain or concentrates Another approach to this problem is to ascertain which crops produce 100 pounds of total digestible nutrients at the lowest cost We have the benefit of the results of an experiment conducted at the Huntley, Montana, experimental field to provide evidence on this point

It is obvious from a study of Table 2 3 that pasture and roughages produce the cheapest nutrients Animals capable of using a large

Table 2 3 Relation of Crops to Cost of Nutrients

Crop and Yield per Acre	Cost of Each 100 Lb of Total Digestible Nutrients Produced
Pasture (grazed 250 days per year)	$0 29
Alfalfa hay (4 7 tons)	0 49
Corn silage (13 7 tons)	0 01
Oats (60 bu)	1 19
Corn (63 bu)	1 29
Barley (40 bu)	1 40

proportion of their daily ration in this form are therefore, economical producers *Table 2 2 indicates that the dairy cow was capable* of obtaining three-fourths of her nutrients in this form thus making her first choice among farm animals for economy of production, when all factors are taken into account

We have just observed that the dairy cow is an excellent consumer of roughage and that she uses feed efficiently Both are splendid assets to the dairyman Now we shall determine her influence upon soil fertility

Dairy farming aids in conserving the fertility of the soil When a crop is harvested it removes a certain amount of plant food from the soil Successive harvests without any program for restoring the elements that are removed, deplete the soil and reduce subsequent crop yields If crops are fed to animals and the manure from the animals is returned to the soil, less plant food is removed from the land

It must be borne in mind, however, that fertility cannot be maintained by returning to the soil an amount of manure equivalent to

that produced by animals consuming only the crops produced on the farm. Even when the manure returned to the soil includes the products from purchased feeds it will not in most instances maintain crop yields.

There is a tendency for many soils, even though heavily manured, to become deficient in calcium and show an acid reaction after continued cropping.

Legume crops are heavy users of the chemical element calcium. Consequently, the soils upon which such crops are grown are more rapidly depleted of certain plant-food elements than the average farmer realizes. For example, alfalfa hay removes slightly less than twice as much nitrogen, the same amount of phosphorus, and almost eight times as much potassium as an equal weight of No. 2 dent corn. A ton of pork removes sixteen times as much nitrogen, eighteen times as much phosphorus, and thirteen times as much potassium as a ton of butter. It should be mentioned, however, that neither pork nor butter is an especially heavy user of plant food. The heavy users of plant food are the grains, hays, and straws when sold directly from the farm. Table 2.4 shows the fertility value and manurial value of various feeds and animal products.

Table 2.4 Fertility and Manurial Value of Feed and Animal Products

Material or Product	Fertility Value per Ton	Manurial Value per Ton
Concentrates		
Dent corn No. 2 grade	$ 5 12	$ 2 81
Oats	7 06	3 87
Barley	7 55	4 15
Wheat bran	13 47	7 92
Linseed meal	20 33	11 06
Soybeans	20 80	11 17
Cottonseed meal (43%)	25 25	13 74
Roughages and pasture		
Corn silage	1 60	0 91
Wheat straw	2 00	1 18
Oats straw	3 81	2 30
Timothy hay	5 40	3 20
Bluegrass	5 83	3 58
Red clover hay	7 66	4 31
Alfalfa hay	9 92	5 62
Animal products		
Butter	0 47	
Milk	2 05	
Pork	7 93	
Steer	9 37	

Precisely what does this table indicate? What can we learn from it? First, the fertility value of a product is determined by the amounts of nitrogen, phosphorus, and potassium present in the material, and what those specific amounts would cost if purchased in standard commercial fertilizers. Generally the costs of the elements N, P, and K bear a ratio to each other of roughly 3, 2, and 1: that is, if nitrogen cost 15 cents per pound, phosphorus would cost 10 cents, and potassium 5 cents per pound.

The manurial value is the residue remaining after the material has been consumed. An analysis of the excrements from animals fed different feeds establishes these values. If we use red clover hay priced as in Table 2.4 as an example, the fertility value is \$7.66 before it is fed. After feeding, the residue from it still contains enough of the original fertilizing constituent to be equivalent to \$4 31. Stated in another way \$4.31 if invested in nitrogen, phosphorus (in the form of P_2O_5), and potassium (K_2O) would buy essentially the same amount of those elements as would be contained in the manure produced by feeding one ton of red clover hay.

It should be mentioned also that legume crops in a rotation, when plowed under directly as green manure, supply nitrogen at from 3 to 5 cents per pound. Therefore soil-building legumes, whether fed or plowed under, provide a cheap source of the element nitrogen. They also add other plant-food elements to the soil in addition to nitrogen

Dairy cattle provide a home market for farm crops. Many farm feeds, notably roughages, are extremely bulky. It is desirable that they be consumed near the source of production and a less bulky cash product sold in their stead. Certain dairy products, particularly cream, are not bulky. Furthermore, on almost every farm there are certain feeds that cannot be readily marketed in their original form; but if they are converted into a highly desirable product such as milk, there is a ready cash market. We have already learned that the dairy cow can use bulky roughages because her digestive system is suited to the utilization of such feeds. Since she is efficient in the process, she makes a good market for their utilization.

In the establishment of desirable crop rotations, legume crops are highly prized. It is more desirable from a fertility and cash income point of view to market these legumes by feeding them to livestock. Their conversion into milk or butterfat on the farm not only furnishes a cash market but also frequently solves the crop marketing problem.

Dairy farming provides a continuous market for labor. Men working in the crafts often receive a high hourly or daily wage Their yearly income, however, is not large because they actually work a relatively small percentage of the year in many instances only 150 to 200 days Certain types of farming have tendencies in the same direction in that many of the farming operations are seasonal in nature The farmer who devotes all of his energies to crop production usually experiences difficulty in finding profitable employment during a portion of the year Under such conditions dairying furnishes a profitable market for extra labor Furthermore, cows require a maximum of attention during the winter months, and a minimum during the summer season when crops make the greatest demands on labor

Much of the work of caring for cows can be easily and quickly done The nature of the work is such that the family, especially the older children, can readily assist in its accomplishment Such work is in no sense harmful unless it involves long hours or prevents the children from attending school

Labor is more productive and yields a higher hourly return if it is expended upon high-producing cows Figure 2 1 is introduced to provide proof for the truth of this statement You will note that, as the yield of milk per cow increases the labor cost of producing each 100 pounds of milk decreases This point namely, that labor yields a greater per hour return if expended upon high-yielding crops or upon cows that produce at high levels, has seldom been adequately stressed in dairy farm operations A farmer's time is a commodity to be merchandized, and it goes to a favorable market when expended upon good crops and good cows

Dairy farming markets a cash crop The dairy farmer is in a sense a salaried employee His income is in cash and is received regularly throughout the year But in a larger sense he is a capitalist and a manufacturer He has the advantages that accrue to a business man, namely, that inventories can be built up in the form of cattle and in productiveness of the soil, at the same time he enjoys the privileges of an employee who has a pay check each month

There are distinct advantages in being identified with a business that has a rapid turnover Under such conditions, operating capital is largely supplied by the business itself in regular amounts and at stated and frequent intervals Bankers have learned that dairymen because of a regular cash income constitute a good risk

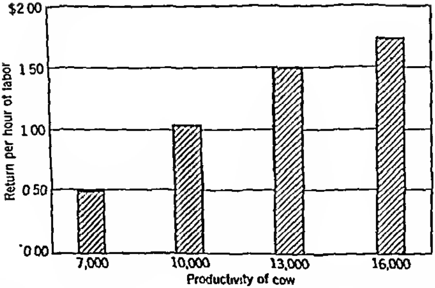


Fig 2 1 Basic productivity of the cow This graph is based upon the following values:

1 Grain, $2.20 per cwt.
2 Protein supplement, $4.70 per cwt
3 Hay, medium quality, $20 per ton
4 Silage, $8 per ton
5 Pasture, depending upon quality, $20–$25 per acre.
6 Milk, valued at $4.00 per cwt
7 Test of milk, 3.5% butterfat

From C R Hoglund, Efficiency Results from Improvements in All Phases of Production J Dairy Sci, Vol XXXVI, No. 12, p 1348, Dec, 1953.

Dairy farming has some disadvantages. It is always desirable in appraising and evaluating any occupation to study its undesirable as well as its favorable qualities If we study certain of the inherent qualities of dairying we will note some that tend to discourage farmers from engaging in the occupation Especially is this true if money can be readily made, even by inefficient operators, in some alternate occupation which requires shorter hours or is less confining in nature.

Dairying *is confining* and *requires long working hours.* In this country cows are milked and fed at least twice each day. To do this someone must be available every night and morning. In the larger dairies it means a considerable working force; in the smaller herds the feeding and milking is most often done before and after a regular day of work in the field. This prolongs the working day, shortens the period for rest and sleep, and tends to reduce the general stamina and resistance to disease of the worker.

Desirable labor is difficult to employ For many years there has been an inclination for young men reared on the farm to seek urban employment This has made it difficult to obtain a sufficient number of desirable workers on the farm particularly in sections near centers of population

Often farmers experienced in crop production do not enjoy working with cows When the herd is large enough to employ regular men by the year it is usually less difficult to secure desirable help If the herd is small and transient help is relied upon the family usually has to do the milking This situation frequently limits the size of the dairy herd Machine milking and other labor saving devices have removed much of the drudgery from dairying and have tended to promote sanitary conditions and a better quality of product

A shortage of qualified labor is one of the greatest deterrents to the expansion of the dairy industry Likewise it more often provides the motive for the dispersal of the herd than any other single reason

Persons who are seeking high hourly rates of pay with short working hours are not interested in seeking employment on dairy farms Therefore dairying never competes favorably with industry in the employment of labor

Dairy farmers have appreciable losses due to disease, accidents, calving hazards, etc As an example let us consider the loss due to one disease brucellosis (contagious abortion) Table 2 5 shows what has occurred with respect to this disease of cattle in the United States as a whole

It should be observed that no separation is made between beef cattle and dairy cattle in this table Both kinds of cattle are included During the first three full years of the brucellosis control program the percentage reaction of cattle was high Then followed four years when the percentage of reactors was quite low Subsequently especially since calfhood vaccination has been practiced reactions have tended to reach a point of equilibrium which appears to center around a mean of 4 per cent

A more general study of why cows are culled from a herd is indicated in Table 2 6 It should be mentioned that in the ordinary operation of the dairy industry approximately 20-22 per cent of the milking cows are eliminated from a herd each year Part of these are removed because of low production or some other undesirable heritable defect Their culling exerts a beneficial genetic influence upon the herd The other causes of herd losses will be equally dis

Table 2.5. Brucellosis Control from July 1, 1934, to Dec. 31, 1052, United States

Year	Herds Tested	Cattle Tested	Total Reactors	Percentage Reactors	Calfhood Vaccinated
1934—6 mo.	78,782	624,318	9,874	1.6	Not reported
1935	368,937	5,391,404	481,734	8.0	" "
1936	585,213	7,690,376	433,985	5.6	" "
1937	614,235	7,679,714	343,413	4.5	" "
1938	737,815	8,072,390	291,509	3.6	" "
1939	665,137	7,137,066	183,375	2.6	" "
1940	622,726	7,124,880	181,238	2.54	" "
1941	657,001	7,277,794	200,839	2.76	15,282 *
1942	458,689	5,781,936	191,424	3.31	173,980
1943	384,710	5,119,893	211,350	4.13	306,411
1944	393,328	5,301,520	237,803	4.49	440,639
1945	382,248	4,944,062	238,971	4.83	582,973
1946	430,502	5,067,903	246,223	4.86	783,889
1947	498,079	5,340,123	237,870	4.45	976,435
1948	540,244	5,484,608	225,298	4.11	1,333,099
1949	607,210	5,951,876	223,033	3.75	1,782,781
1950	555,884	5,467,134	182,225	3.33	2,053,636
1051	592,324	6,101,667	200,161	3.28	2,814,512
1052	685,247	7,918,526	318,404	4.00	3,307,092
Ave. 1934–1942		56,779,878	2,317,391	4.08	
Ave. 1943–1952		56,697,312	2,321,428	4.09	

* Began reporting July 1, 1941.

Table 2.6. Reasons for Removing Cows from Illinois Dairy Herds, Taken from D.H.I.A. Testers Reports for 1950 and 1951

Reason for Removal	Per Cent of All Cows Removed 1950	1951
Low production	43.7	48.0
Dairy purposes	17.8	16.0
Sterility	10.1	8.0
Udder trouble	9.4	8.0
Other reasons	8.6	9.6
Died	6.3	5.7
Accident	1.7	2.0
Abortion	1.7	1.6
T.B.	0.7	1.1

tributed between the good and poor cows and therefore will exert no important genetic influence and no improvement.

Dairy farming requires a considerable amount of capital. Capital provides the instruments of production A dairy farmer has more money invested in buildings, machinery, raw materials (feed), etc.,

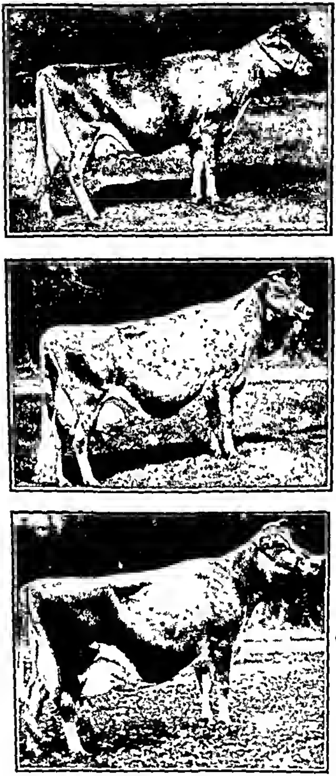
than the average farmer Furthermore, labor on a dairy farm is more productive when it is working with more and better tools and with superior cows As more capital is invested per man, production per worker tends to increase It should be recognized, however, that here, as elsewhere, the law of diminishing returns is operative and that additional capital invested beyond that which is required for production efficiency tends to reduce net income

There are two factors that work to the advantage of a dairy farmer, especially to the breeder of purebred cattle They are (1) time and (2) the reproductive capacity of cattle A young man who may lack sufficient capital to obtain the size of herd he wants may depend upon time as a substitute for capital The reproductive rate of cows will in the course of a few years provide him with the progeny he needs to complete his herd If this program for development is followed, it is highly important that the foundation animals possess desirable germ plasm, otherwise the herd may grow to the proper size but lack in productive capacity

Substitutes are providing severe competition for dairy products Dairy farmers and processors of dairy products should look ahead with the realization that many of their products are now selling on a competitive market Merchandising is thus of greater importance to the industry than it has been in the past decades Under such conditions efficiency of production is a great asset to the dairyman because it will enable him to sell his products at a lower price At the same time he should constantly improve the quality of his product because a better product discourages the use of substitutes

The encroachment of oleomargarine into the butter market and filled products into the market for ice cream does not constitute occasion for alarm There are alternate, and generally more profitable, uses now being made of the milk that was formerly utilized in these products Nutritionally and for the promotion of health there is great need for additional milk.

Do I have the qualities to become a successful dairy farmer? Some men succeed where others fail in the operation of a dairy enterprise Generally those who do well possess certain qualities that are recognized in all good dairymen The dairy venture has two highly important components They are (1) the ability to handle livestock and (2) the capacity to grow and harvest crops that yield well It is the ability to combine these two qualities that insure successful dairy farm operation



(a)

(b)

(c)

Fig. 2.2. Photographs *a*, *b*, and *c* are of the outstanding Jersey cow, Brampton Belle Beacon. They represent different stages in her development. In *a* she was 3 years of age; *b* shows her more nearly developed about 2 years later; *c* shows her in her fully developed form and about 7 months after her last calving

Good dairymen are fond of animals Very rarely will a man be successful with livestock without possessing a fondness for animals No man can derive any satisfying pleasure from working with animals unless he has a genuine love for them Such liking for animals will take the drudgery out of going to the barn at night to make sure that they are comfortable and will cause one to fight for an animal that is being abused

Furthermore animals react favorably to attention and kindly treatment Some time ago one of the authors noticed that the heifers in a certain herd after having their first calves kicked badly when they were broken to milk It was not just one but the majority of the heifers that reacted in this way The condition was so unusual that observations were made to determine the cause After several weeks of careful study it was decided that the trouble originated in the calf barn Thereupon a new man with a different temperament and a fondness for calves was placed in charge and when animals of similar inheritance reared by this man came into milk the trouble did not appear The first man had been nervous he had hurried and prodded the calves and it was noticed that the little fellows would run from him and kick at him when his back was turned Kindness and a fondness for calves on the part of the new man completely changed the reaction of the heifers to their surroundings

Successful dairymen understand the principles of breeding and feeding There is an interplay between science and art in the breeding and feeding of dairy cattle Many experiments have been conducted to ascertain the facts about the nutrition of calves and cows Much of this knowledge is of practical use in the barn The same is true of the application of genetic principles to the breeding of dairy cattle The most successful dairymen try to take advantage of the more important discoveries in both fields

A dairyman should be able to overcome disappointments It is not easy to do everything in one s power and then have a valuable animal sicken and die It is at such a time that a person s courage is thoroughly tested Unless a dairyman can endure such disappointments he will sooner or later become discouraged and this is one of the first signs of approaching failure The true dairyman will recover quickly from his losses try to profit by his experiences and if necessary put more effort into his work He will find his reward in the response his animals make to his care and in building a successful enterprise

A good dairyman needs to possess the spirit of cooperation Many of the control measures and informational practices of the successful dairy farmer are community enterprises Dairy-herd improvement associations, artificial breeding organizations, marketing agencies, etc are, or can be made to be, cooperative in nature Too active a participation in the management of such enterprises may consume a large portion of the time of the dairyman and thereby produce an unfavorable effect upon his farm operations and his income In general, however membership and participation in the activities of such organizations are advantageous

Any person who contemplates devoting his (or her) life to the operation of a dairy enterprise should carefully consider the advantages and disadvantages of the industry and decide whether or not his own qualities equip him to be successful in that occupation

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REVIEW

1 What usually determines whether an idea is true or false?

2 List the main advantages associated with dairy farming

3 Compare the cost per 100 lb of digestible nutrients in farm crops Which three crops produce nutrients most cheaply?

4 Why does dairy farming aid in conserving the soil?

5 Name three advantages of dairy farming over grain farming

6 Name three disadvantages of dairy farming

7 List three qualities that a good dairy farmer usually possesses

8 Under what conditions in dairy farming is labor most productive?

3

Selecting the Dairy Cow

Judging is a visual evaluation of a three dimensional object Cows do not necessarily look alike but they possess many common characteristics In selection we are interested in both their similarities and their differences Particularly do differences in cows vary in details and these details vary in value and importance Furthermore, two people do not view the same thing exactly alike What they see is evaluated in terms of something they have observed before It takes an accumulation of similar experiences to produce a concept But experiences alone are not sufficient unless they are compared with each other In short, a concept is gained when a series of observations are studied reflectively in terms of each other

A good judge of dairy cattle must see a large number of animals that represent a variety of characteristics He will study these animals part by part Then he assembles the parts that impress him most favorably into his concept of a cow His concept or ideal then is not what a cow is but what he decides she ought to be This concept is a real thing It can upon occasion be reproduced into a mental image that becomes a standard against which real objects can be compared

The first characteristic of a good judge of dairy animals is accurate observation Two people seldom see the same animal precisely alike and they do not give the same interpretation to what they do see It was Gipsy Smith, the great evangelist, who is responsible for the statement, ' The eye sees what the eye has means of seeing " Therefore the ability to observe and evaluate differences in cattle must be cultivated It is acquired gradually and with personal effort The remainder of this chapter will attempt to provide a basis for the student to use in visualizing and evaluating the important qualities in cattle

Form is correlated to function It has been demonstrated that there is a definite relation between the form of a cow and her ability to produce milk To be able, consistently and accurately, to recog-

nize in the individual cow the physical characteristics that indicate her ability to produce large yields of milk is almost a priceless asset to any dairyman One is able to do this only by the careful and close observation of a large number of cows that differ in form and in yield of milk Thus one learns by association to distinguish the characteristics that accompany production capacity

Learn to choose the right kind of cow. Breeders and dairymen have reached the conclusion that the most profitable cow is one that

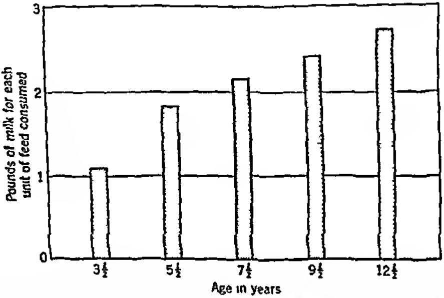


FIG 3 1 Cows that wear well produce milk cheaper This chart taken from Kvaegavlen i Jylland, 1933, shows that Danish cows during their lifetime produce milk more cheaply per unit of feed consumed if they live to an advanced age

attains a fairly high level of production and yields essentially at that level year after year for a relatively long life To accomplish this a cow must possess a certain amount of quality and substance, much of which, no doubt, is a heritage that has come to her through her ancestors In such cases the cow cannot have conspicuous weaknesses that are almost certain, sooner or later, to cause the animal to break down and necessitate her removal from the herd

The advantages of a long productive life are shown in Figure 3 1, which clearly indicates that the feed cost of producing a pound of milk is less than half as much for cows that have a productive life of 12½ years as for cows that remain in the herd only 3½ years This is a highly significant point in the economy of milk production

Choose cows that calve regularly. There are wide differences between cows in the regularity with which they produce their calves

Some cows are known as "shy breeders," and such cows are seldom profitable animals[1] In a study made at the University of Illinois it was observed that healthy cows with poor calving records usually continued to be problem animals and were not desirable in the herd

Avoid cows with a tendency to udder trouble. First-calf heifers with extremely large, highly inflamed udders seldom make good mature cows Such overdevelopment in a young animal usually causes the udder to become loose in its attachment to the body This condition may not appear to be serious at the time, but with further development at subsequent calvings, udders of this type pull away from their attachment to the body of the animal, hang very near the ground, and are subject to injury Furthermore, such udders are difficult to milk either by hand or with machines

Udders of poor quality or texture, those that have a high percentage of connective or supporting tissue to secreting tissue, are not only more inclined to injury but also have a greater tendency to mastitis[2]

Avoid cows with crooked legs, open shoulders, and weak constitutions. These conditions are all evidences of weakness in the animal They belong to the classification of those defects that grow worse as the animal advances in age Some defects as lack of depth of body, slightly sloping rump in a young or thin animal, or udder somewhat lacking in size in a heifer can and oftentimes do clear up somewhat as the animal matures The defects listed above, however, almost always grow worse with age and should be avoided

Choose for ruggedness and freedom from weakness. In a study recently made of the Ayrshire breed, it was observed that those cows that produce more than one hundred thousand pounds of milk in their lifetime display unusual stamina and ruggedness Such cows are highly desirable and usually the most profitable animals in the herd Furthermore, such animals usually mature slowly and show a greater ability to increase in yield of milk from the first to the second and the second to the third lactation than the average cow of the breed This is a desirable quality and is associated with longevity, another valued quality in the cow

[1] It is understood that we are considering here only healthy cows that have been demonstrated by certain specific tests to be free of infectious diseases and not those that because of such infections abort or have bad calving histories

[2] Any disease or condition that causes the udder to swell up in one or more quarters any tendency to produce "stringy" or "clotty" milk, or any other disturbance in an udder is usually spoken of as mastitis

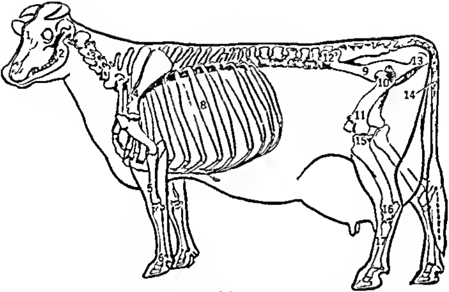
Become familiar with the names of the parts of a cow. In comparing two animals or in measuring a cow in terms of a mental image of what she ought to be, evaluate portions of the animal such as head, topline, legs, udder, etc., rather than considering the whole animal. Then after summing up the advantages and disadvantages make the decision as to which, all things considered, is the better individual. Describing an animal or comparing two different individuals is most effectively done by considering one part at a time. At the very outset it is necessary to become familiar with the names of these parts. Study Figure 3.2 carefully and from it be able to locate all of the parts shown on a living cow.

Make note of these items about the head, neck, and shoulders. Begin with the muzzle which is the portion around and continuing slightly above the nostrils and then proceed upward locating the eye, the middle of the face—where some dish is expected—the horns, and the poll. Observe the relation of the length to the width of head. Note the length of neck and whether or not the throat is clean-cut. Look carefully at the withers and observe whether or not the spinal processes are higher than the shoulder blades

Identify the different parts of the body and legs. First study the topline, and learn to know the difference between the back, loin, and rump regions Observe the heart girth, or the distance around the body just back of the shoulders. Note on the chart how much deeper the barrel is in the rear portion than in the front. See if this is true in the animals you study. Note the position of the hooks and pin bones. Observe whether or not the animal stands straight on its hind legs, as does the cow on the chart, or whether there is a greater bend at the hock (sickle-hocked). When viewed from the rear are the hind legs together at the hocks with feet apart (cow-hocked), or are the legs straight?

Study the milking organs. Observe carefully the udder as it appears on the chart. Compare its size with the size of the entire cow. Make a similar comparison in cows that you study. As you have opportunity to inspect cows, observe the forward and rear attachments of the udder and note the size and location of the teats and the position of the milk veins. Find the milk well by feeling with your index finger at the end of the milk vein

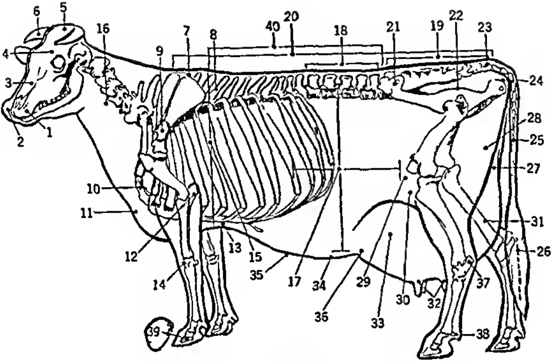
Choose well-developed capable animals. In general, dairy cattle breeders, other factors remaining the same, prefer well-developed animals that are equal to or above the average of their breed in size. The failure of an animal to grow to proper size may be due to several



(a)

Fig 3.2a Bone structure (common usage terms) of a cow

1 Head
2 Jawbone
3 Neck bones
4 Shoulder blade
5 Leg bones
6 Pastern joints (front and rear)
7 Backbone
8 Ribs
9 Pelvic bones
10 Thurl joint
11 Thighbones
12 Hook bone
13 Pin bone
14 Tail bone
15 Stifle joint
16 Hock joint
17 Cannon bone



(b)

FIG 3.2b Location and names of the parts of a cow

1 Muzzle
2 Nostril
3 Bridge of nose
4 Forehead
5 Poll
6 Horns
7 Wither
8 Crops
9 Shoulder
10 Shoulder point
11 Dewlap
12 Elbow
13 Chest floor
14 Knee
15 Heart girth
16 Neck
17 Barrel
18 *Loin*
19 Rump
20 Topline
21 Hooks
22 Thurl
23 Tailhead
24 Pin bones
25 Tail
26 Switch
27 Rear udder attachment
28 Thigh
29 Stifle
30 Rear flank
31 *Rear udder*
32 Teats
33 Fore udder
34 Mammary veins
35 Milk wells
36 Fore udder attachment
37 Hock
38 Dewclaws
39 Hoof
40 Back

causes among them (1) lack of feed of the proper kind and quantity to produce normal growth and development (2) unfavorable combination of hereditary characters (3) disease and improper management Calves with good inheritance but from stunted parents may be developed to normal size by proper feeding On the other hand calves from parents that are small because of undesirable hereditary characters will be likely to remain small no matter how they may be fed

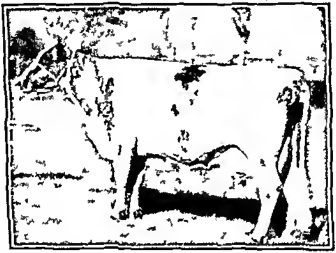


Fig 33 Note the udder veination and evidence of great production in the mammary system of the Ayrshire cow Ardgowan Valla She produced 31 158 lb of milk and 1356 lb of butterfat This cow combines dairy tendency and mammary development to a high degree

Estimate the weights of five well grown and five undersized mature cows Select five cows that are well grown for their breed and five that are small Choose if possible cows that are of similar breeding and in approximately the same condition of flesh Estimate the weights of these cows and then check your estimates with the actual weights of the animals over the scales If scales are not available, use a weight tape or ask a number of farmers or experienced cattle buyers to estimate the weights and take the average of their estimates as the check upon your own Note the variation between your estimate and the actual weight or average estimate for each cow Attempt to determine why your estimates were not in agreement with the actual weights Profit by this procedure when you again estimate the weight of an animal

Measure their height and length of body. When two animals of the same height and length of body differ in weight, the differences may be due to either of two factors (1) difference in general form, or (2) difference in condition of flesh If the cows that you have selected are gentle, measure their heights at the withers If they are not gentle, measure the heights of other cows of different sizes and forms

In measuring the height at the withers, be sure that the animal is standing squarely on its feet and is in a normal position Use a standard[1] graduated in centimeters or inches, preferably one with an adjustable arm at right angles to the main standard Place the standard on the ground and perpendicular to it (Some standards are equipped with a spirit level to aid in keeping the instrument exactly perpendicular) Lower the adjustable bar until it touches the highest point of the withers of the animal to be measured, and take your readings for height from the underside of the bar on the graduated scale of the standard

Obtain the length of body by measuring the horizontal distance between shoulder points and pin bones

Become familiar with the average size and weight of both young and mature females of the different breeds. It is important to know how large an animal of a given age and breed ought to be Perhaps as reliable a standard or norm as any for cattle of the different breeds is found in Table 3 1 for animals from birth to maturity

Are the calves and heifers you are accustomed to see as large as or larger than the averages given for the different ages and breeds in Table 3 1? Find the answer to this question by putting a weight tape measure around the chest of the animal just back of the forelegs[2] if you do not have scales available for weighing animals By repeating this procedure on several different animals, you can become proficient in estimating the weight of young animals Follow the same procedure for milking cows By this method you can become a good judge of size

Dairy tendency or lactation drive is a valuable quality in a dairy cow. The natural function of milk production in the dairy cow is

[1] A splendid set of measuring instruments can be obtained through Eimer & Amend, Third Avenue and 18th Street New York City This set includes a caliper and standard similar to those illustrated in Figure 3 9

[2] Tapes of this type graduated to record in pounds may be obtained from the Chicago Tape and Label Company, Chicago Ill, or from Purina Mills, St Louis, Mo

Table 3.1 The Influence of Age upon the Height and Weight of Dairy Heifers *

	Ayrshire		Guernsey		Jersey		Holstein	
Age mo	Weight lb	Height at Withers in	Weight lb	Height at Withers in	Weight lb	Height at Withers in	Weight lb	Height at Withers in
Birth	72	27.6	65	26.6	53	25.7	90	29.1
1	89	28.6	77	28.2	67	27.0	112	30.6
2	119	30.2	102	29.8	90	28.9	148	32.3
3	158	31.9	133	31.6	121	30.6	193	34.3
4	198	34.0	173	33.5	158	32.6	243	36.2
5	245	35.5	210	35.3	199	34.5	297	37.7
6	293	37.2	260	36.9	243	36.2	355	39.7
7	344	38.5	305	38.4	286	37.7	410	41.1
8	389	39.9	350	39.9	324	39.0	462	42.3
9	433	40.9	389	40.9	360	40.1	509	43.5
10	469	41.7	427	41.7	393	40.9	552	44.4
11	502	42.5	459	42.6	420	41.7	593	45.3
12	538	43.2	490	43.3	450	42.2	632	46.0
15	638	45.1	584	45.0	530	43.9	746	47.9
18	725	46.5	663	46.4	601	45.2	845	49.3
21	818	47.6	737	47.3	665	46.2	952	50.6
24	902	48.3	818	48.0	733	46.9	1069	51.7
30	945	48.3	880	49.3	824	47.9	1120	52.6
36	968	48.7	901	49.9	855	48.2	1165	53.0
48	1035	50.2	990	50.4	897	48.5	1232	53.3
60	1080	50.4	1055	50.6	937	49.0	1330	53.6
96	1143	49.2	1070	49.6	909	47.7	1365	53.2

* Mo Exp Sta Bul 336

highly *developed* Cows that possess a highly developed dairy tendency will *sacrifice*, if necessary, their own tissues to produce milk It has been observed that cows will use up as much as one-fifth or one sixth of their own tissues (*providing they* are in fairly high condition at calving time) in the production of milk This pronounced disposition to produce milk is termed dairy tendency, technically spoken of as lactation drive, and contrasts the dairy cow from the beef animal which utilizes its feed for addition to its own tissues All cows do not possess the quality of dairy tendency to the same degree The task of the dairyman is, therefore, to be able to distinguish between the cows that are highly developed in this respect and those that are lacking in this quality

A good producing cow usually has a clean cut face and a long slender neck The face of a good dairy cow if viewed from a position directly in front of the animal should be somewhat dished between and slightly above the eyes, and the face should be lean and clean cut looking especially when the cow is in heavy milk production The season of year and length of hair must, of course, be taken into con-

Production and cost accounting records show that a cow must be four and a half or five years old before she pays her owner for the cost of her keep prior to the time she reaches a productive age In other words until a heifer is in production she has no opportunity to supply any income to her owner Her keep up to that time is wholly an expense Furthermore, it is only that portion of yield that is above the amount required to currently pay costs of production that can be regarded as a payment on the cost of growing the individual to productive age

It is only the higher yielding cows that can pay their way as they go and also contribute before they are five years of age, a profit sufficient to reimburse their owner for rearing them The strain upon this kind of cow makes unusual demands upon the constitution It is therefore highly important to choose cows that are vigorous and possess durability

A durable dairy cow has a good depth and breadth of chest Stand in front of the animal you are observing and note whether or not she has a broad full chest with a good width between the front legs Observe also whether or not the chest is full and well rounded out at the elbows Look down over the shoulders of the animal and determine the width of the chest and the spring of the upper rib

Late maturity is associated with longevity A study of Ayrshire cows[1] that have produced more than 100 000 pounds of milk during their lifetime indicates

1 That such cows produce less milk in their first lactation than the average Ayrshire cow

2 That their highest production for a single lactation occurs when they are 9 years of age rather than at 7 years which is the age of highest yield for the average Ayrshire cow

3 That there is a greater increase in yield in the second lactation over the first and in the third over the second lactation than in the average Ayrshire

It requires both a high level of production and longevity to make it possible for a cow to produce 100 000 pounds of milk in her lifetime

Durable cows usually appear younger looking than they are The matter of early maturity in meat producing animals has received much emphasis. Animals that have the smoothness and finish that the market demands at an early age are usually produced at the

[1] This study was made by Professor E E Ormiston of the University of Illinois It included cows kept in the United States Canada and Great Britain.

lowest cost Of late years the market has demanded smaller cuts, which has meant that animals are marketed at an earlier age

In dairy cattle, however, two functions must be emphasized first, reproduction, and second, milk production The first of these initiates the second, and the more times the process is repeated in a profitable animal the more desirable the individual It has been demonstrated that slow-maturing animals, with dense bone, trim shapely joints, and displaying quality throughout, are more likely to stand up well than early-maturing, coarse-boned, puffy-jointed, crooked-legged, and open-shouldered animals

Durable cows are usually good roughage eaters. A good appetite is an asset to a dairy cow As we previously have emphasized, nature endowed the cow with a digestive system especially designed for and adapted to the storage, use, and digestion of bulky roughages, and if the dairyman takes proper advantage of nature's provision, he will make full use of the cow's roughage-eating ability

All cows are not equally well fitted by nature for this purpose A good judge of a dairy cow will choose those cows that possess those qualities associated with roughage consumption

Pick cows with relatively long, broad, and deep bodies. Cows are usually longer in body in proportion to their height than bulls They are also required, because of milk production, to consume a larger amount of feed for a given weight of animal Observe cows in your herd or vicinity, and determine whether or not the long-bodied cows with well-sprung ribs are regarded as the largest eaters

Select greedy eaters. Watch several cows while they are eating and note the differences in the way in which they consume their feed Observe cows at pasture, and study their methods of eating Count the number of bites which several of them take per minute

Check this characteristic in a cow and you will find that there is a positive correlation between the rate at which feed is ingested, the total time consumed in eating, and the yield of milk in a given interval of time *This relationship is especially obvious* if cows derive most of their feed from pasture

Avoid cows with defects that grow worse with age Perhaps we will find it to advantage to classify defects They may be separated into two major groups those that improve with development, and those that grow worse with advancing age If defects improve, and there are some that tend to as an animal matures, they are not deemed to be permanently serious Examples of such defects are lack of body depth in a young animal, moderately sloping rump,

and slightly lower than average production in a slow-maturing, first-calf heifer. Such defects tend to correct themselves as the animal develops, but the situation is much more serious with those defects that grow worse as the animal matures. Examples of this type of defect are low back, crooked hind legs, open shoulders, loosely attached udders, bad feet, and long large teats. Avoid such defects, and do not select breeding animals from parents with these defects, especially if they are bad enough to interfere with the proper functioning of the animal.

Pick foundation animals from long-lived, durable families. Fortunately, long-lived families are most likely to be free of the defects that grow worse with age; otherwise most members of the family would not have attained advanced age. Care should be exercised to choose breeding animals, bulls especially, from families that do not possess defects that grow worse from year to year. The main reason for exercising care is that such defects are for the most part of hereditary origin. They should not be extensively perpetuated in any well-managed dairy herd.

Choose cows with sound durable udders. Many years ago one of the authors was judging at a national show. After a class was judged, one of the exhibitors complained that his young cow which had won her class at an equally important show the previous year

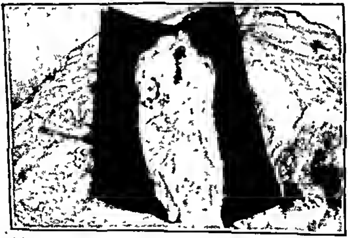


Fig. 34. This udder, having been removed from the body of the cow, shows the median suspensory ligament dissected out and separated from the mammary tissue by pieces of black paper. In this case the support was about 4 inches wide and 8 inches long.

was only awarded sixth position in this show A most highly regarded breeder with long experience, and a man who had owned many of the breed's greatest animals, overhearing the conversation made this observation to the exhibitor, "John, no bag no cow" The weakness in this cow had, of course, been a loosely attached, pendulous udder

No udder, no cow, is a terse but quite an accurate observation Perhaps no single part of the cow is so important in determining her milk-producing commercial, or sale value as the udder Because of this, extreme care should be taken in examining the udder The mammary gland is composed of several kinds of tissue Secreting tissue, which is directly responsible for milk production, is soft, highly vascular, and causes the empty udder to feel much like a sponge to the touch Supporting tissue is much firmer It provides the supporting structure for secreting tissue and if present in large amounts it gives the udder a rather rigid and hard feeling when it is handled Such udders are said to have poor texture, and not a great deal is expected of them in milk secretion

Give preference to a cow with a medium-sized, well-proportioned udder If an udder is too small it may lack in capacity Good texture can, however, compensate to a considerable degree for a deficiency in size If an udder is too large it is subject to injury and often has poor texture The most satisfactory method to be used in judging the soundness and condition of an udder is to observe it before milking and again after milking In the examination of an udder in this way, it is important to know when the animal was last milked It is possible then to estimate how much of the size is due to the milk contained and how much to the tissues of the gland itself On milking out the udder should be reduced materially in size and the texture should be soft and spongy

Age is an important factor in the development of an udder Young cows cannot be expected to show the development in this organ that is found in mature animals Lack of size, if the texture is good, in a first calf heifer is not as serious an objection as the same degree of deficiency in an older cow

It has been demonstrated by numerous experiments that 55–65 per cent of the yield of milk in normal animals is the product of the two rear quarters A desirable balance is shown when not more than this portion of the milk comes from the rear quarters A greater difference than this between the front and rear quarters usually means that there is a lack of balance or an unevenness in the de-

velopment between these **two parts of** *the udder.* The two front quarters and the two rear quarters should tend to match each other in size and development

See that the udder is held snugly to the body. It is important that the udder be attached high and wide at the rear. When it is so attached there seems to be less tendency for the tissues to relax and permit the udder to break away from the body. Furthermore, an udder with a high, wide rear attachment is usually wider than one

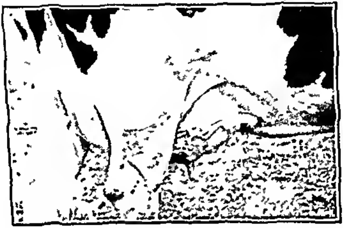


Fig 3.5 An udder rated excellent when this cow was officially classified for type This udder has capacity without extreme size a highly desirable quality

with a narrow attachment and so has good *capacity without extreme depth.* The front attachment of the udder should extend well forward and be slightly wider than the rear attachment There should be no tendency for a separation between the udder and the body of the animal The tendency for an udder to "break away" from the body becomes *more pronounced* with each succeeding lactation

Perhaps the most serious fault that an udder can have, insofar as attachments are concerned, is the failure of the median or central support The median suspensory ligament provides the principal support for the udder If it fails, the center of the udder drops down, the teats, instead *of pointing directly* downward, point outward, and the udder is badly misshapen Furthermore, when this condition is pronounced, machine milking is done with great difficulty, and the cow loses most or all of her usefulness in the herd Figure 3 4 shows the median suspensory ligament dissected out and photographed The cow was a young animal milking in her first lactation

Select an udder that is properly shaped Animals with well-shaped udders are in demand Figure 3 5 shows a Holstein cow with an ideally shaped udder Notice the high rear attachment and the equally developed rear quarters Observe also the well-developed front quarters and the snugness with which the udder is held to the body, even though the udder is bagged [1] to its full capacity Figure 3 6 also pictures a desirable type of udder This udder is not dis-

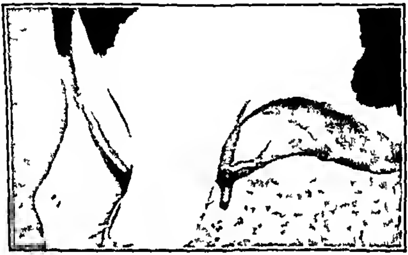


FIG 3 6 This Holstein udder has excellent texture and desirable shape The cow was well advanced in lactation when this photograph was taken

tended by bagging but is of normal working size Figure 3 7 illustrates an udder deficient in front quarters and lacking proper balance Another deficiency not uncommonly found is badly divided quarters This is especially common in the front quarters Figure 3 8 gives an idea of such an udder

Examine the udder for texture and quality It is highly desirable that the udder be of good texture or in other words contain a high percentage of secreting tissue Such an udder is capable of producing more milk per given unit of tissue than one that possesses a higher proportion of connective tissue It is almost impossible to judge the texture when an udder is highly distended with milk When this happens it will be necessary to remove the milk and examine the empty udder An udder that collapses when milked out and is loose and pliable when handled is ordinarily one of good texture Udders that are hard and meaty' to the touch are often associated with a lack of persistency in the cow

[1] Bagging a cow is permitting milk to accumulate in the udder until there is much distention and every portion of the gland is filled with milk

FIG 37 This udder is undesirable in shape and texture The front quarters are poorly developed The front teats do not point straight downward but outward and backward and the median support has failed

FIG 38 This udder provides an excellent example in a relatively young cow of an udder that is badly divided between the two halves This udder is also faulty in front attachment Udders of this type are usually poor in texture and subject to injury

Observe whether or not teats are well placed and of proper size. The teats are well located on the udder when set at least six inches apart from front to rear and almost an equal distance apart from

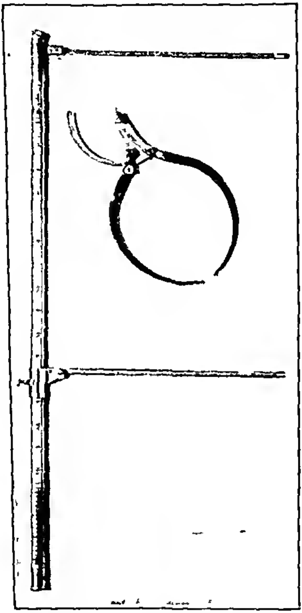


FIG 39. Measuring standard and caliper. These instruments are useful in measuring dairy animals quickly and accurately.

side to side. Teats that are too close together interfere with the operation of milking. Teats should be large enough to be grasped readily by the hand and yet not so large as to make milking difficult. Teats that are too small make machine milking somewhat difficult and hand milking slow and tiresome.

Examine teats for warts, extra openings, or leakage The teat should be smooth and free from warts If warts are present they can sometimes be reduced and softened by the application of Vaseline sweet oil or some similar substance Occasionally there is an extra opening in the side of a teat Not infrequently a cow is found whose sphincter muscle, which ordinarily closes the opening of the teat, does not function normally The result is that the milk drips or at times may even run in small streams from one or more teats This condition is undesirable even though cows so affected are usually easy milkers

Notice development of milk veins and wells Perhaps no two terms are more frequently misunderstood than milk vein and milk well The name milk vein would seem to indicate that the vein contained and carried milk This is not true The milk vein carries blood from the udder toward the heart, for purification It thus performs the same function as other veins all of which carry blood to the heart Two milk veins are located on either side of the animal just in front of the udder and extend along the underline beneath the skin The openings through which these veins enter the body cavity are termed milk wells Generally there are but two openings or wells, one on either side Not infrequently the milk vein separates into a number of branches each one of which enters the body cavity through a separate opening Cases are reported in which as many as thirteen openings or milk wells have been observed in a single animal

Large milk veins and milk wells are associated with high milk yield It must be borne in mind however that extreme development usually appears in older animals Large milk veins and wells are more an evidence that cows have produced heavily in the past than that they will produce well in the future

It should be recognized that the milk vein the subcutaneous vein that you can observe on the outside of the body, is not the only one that can carry blood from the udder to the heart Two internal veins on each side generally smaller in size than the external veins also provide exits for the venous blood Therefore it is not so essential that the external veins be large to insure an adequate blood flow through the udder

Use production records whenever possible to aid in making selections It is highly desirable to know how to choose the right kind of a dairy cow but an operator should obtain all of the valid evidence possible when selecting milking animals Authentic production rec

FIG 3 10. This cow, an excellent producer, went out of the herd because of very bad feet and legs This defect is highly heritable and should be carefully evaluated in a breeding program

ords such as those kept by the Dairy Herd Improvement Association, the Herd Improvement Registry, or the Advanced Registry present proof of productive capacity. It should be recognized, however, that the conditions under which records are made have a definite influence upon the size of the record. Such variables as age at time of calving, number of milkings per day, length of previous dry period, whether or not a calf was carried during the major part of the lactation, kind and quantity of feed, and nature of management are all factors that contribute to a lactation record Add to these major genetic influences such as lactation drive and per cent fat content of milk, and it should be apparent that production records require some interpretation as to their real meaning.

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REVIEW

1 What are the characteristics of a good judge of dairy cattle?
2 What do we mean by longevity in a cow? What qualities in the animal portray durability?
3 What udder weaknesses should a breeder avoid?
4 Name 10 important bones or parts of the skeleton of a cow
5 Identify two types of crooked hind legs.
6 What is lactation drive? How do you evaluate the quality in the cow?
7 Give three qualities possessed by cows that had produced 100 000 lb milk
8 What qualities of a cow tend to grow worse with age?
9 Name the characteristics that may improve with development
10 What are the characteristics of a good udder?
11 How do you evaluate udder texture?
12 What agencies have been provided to test cows for yield?

4

Selecting a Breed

In the process of dairy cattle development selective influences have caused cattle to possess different characteristics This differentiation has to some extent been fixed and preserved by the establishment of breeds Many of the characteristics of breeds overlap For example, the highest percentage of fat content found in cows of the Holstein breed is greater than the lowest percentage of fat observed in members of the Jersey breed This same condition applies to certain conformational differences, muscular and bone structure, milk yield, etc But breed differences are real differences, and most of them are heritable The validity of breed differences is tested and supported by the consistency of the averages for the variable characteristics possessed by the different breeds To cite an example, Table 4 1 shows how the five major breeds differ in the percentage of fat content of their milk Since there is a very high correlation between the percentage of fat content of milk and the solids other than fat in the milk (several investigators have found an 80 per cent correlation), the curves for the milk composition of the breeds would resemble somewhat those of Table 4 1 for fat

A question frequently asked is, "Which is the best dairy breed?" Obviously, this question cannot be intelligently answered until certain facts regarding market, climate, systems of management, and local conditions are known Furthermore, it must be realized that inferior animals of one breed cannot compete on even terms with superior animals of another breed even though these superior animals are not so well endowed by nature for the market and conditions in question In short, superiority within a breed is more important to a dairyman than the adaptations between breeds

Characteristics of the major breeds of dairy cattle. A review of the history of cattle development supports the view that our present breeds of dairy cattle originated from the same foundation stock Selection for different objectives, over a long period of time, has resulted in the development of rather wide differences It is, there-

Table 4.1. Characteristics of the Five Major Breeds of Dairy Cattle

Characteristic	Ayrshire	Brown Swiss	Guernsey	Holstein-Friesian	Jersey
Place of origin	Scotland	Switzerland	Guernsey Isle	Holland & Friesland	Jersey Isle
Date of first successful importation	1822	1869	1830	1861	1850
Date present registry association established	1863	1888	1877	1885	1868
Highest recorded milk yield per cow to June 1, 1953	13,1[illegible]6	31,283	26,672	42,805	23,725
Highest recorded fat yield per cow to June 1, 1953	1,356	1,379	1,223	1,511	1,319
Ave yield of milk expected under farm conditions	8,000	9,000	6,500	9,750	6,000
Desirable age at first calving (range)	26–28 mo	30–34 mo	25–27 mo	27–30 mo	23–25 mo
Ave fat content in milk, %	4.00	4.00	5.00	3.45	5.40
Weight					
Desirable for mature bulls (range)	1,700–2,000	1,850–2,500	1,600–1,800	2,100–2,800	1,350–1,600
Desirable for mature cows	1,000–1,400	1,250–1,500	1,000–1,250	1,300–1,750	900–1,100
Ave. birth weight of calves	75	100	70	90	55
Bull calves weigh slightly more heifer calves weigh slightly less					
Prevailing color	Red and white spotted	Light gray to almost black	Orange-fawn and white spotted	Black and white spotted	Light to dark fawn, solid or spotted

fore, highly desirable to analyze the different breeds for likenesses and differences and then evaluate the significance of these differences to potential dairymen

Identify breeds by color differences. Three of the major breeds of dairy cattle are naturally spotted These are the Holstein, Guernsey, and Ayrshire, the Holstein being black and white spotted with a definite line of demarcation between the black and the white Occasionally animals of this breed have small irregular spots, but usually the spots are fairly large and the separation distinct Occasionally in the older animals there will be a graying appearance, particularly about the head, neck, and over the shoulders When this takes place, the animals may become quite grayish in appearance This is somewhat objectionable, but does not bar the animal from record unless it occurs at an early age and is quite marked

The ratio of black to white in the Holstein breed varies markedly Registration requirements stipulate that an animal cannot be completely white (a few black hairs suffice to meet this requirement), and regulations requiring a white switch and some white on legs, especially at the hoof-head, preclude the animal from being self

(solid) black Thus animals may vary in color, so long as the colors are black and white, between these two extremes

The Guernsey is of a lemon or orange-fawn color, occasionally approaching red, with white markings The line of demarcation between the fawn and the white is usually distinct Guernseys are also characterized by a buff-colored muzzle and pinkish pigmentation around the eyes and on the unhaired portions of the body Occasionally dark-colored or cloudy muzzles are observed These are somewhat objectionable and they are viewed as more undesirable in bulls than in cows

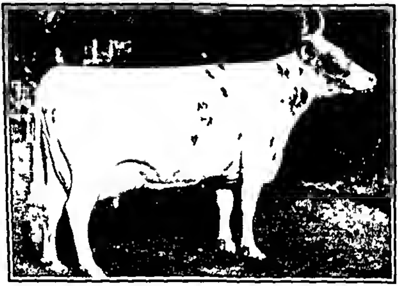

FIG 41 Alfalfa Farm Ann II a very superior cow of the Ayrshire breed She combines good conformation and productive capacity

The Ayrshire, the third of the naturally spotted breeds, has varying shades of red, approaching in some instances almost black, and white With the Ayrshire the spots are usually indistinct, and sometimes the line of separation between the colored and white portions is irregular and somewhat splashed in appearance

The Jersey is usually solid color, varying from a lightish fawn to black Occasionally spotting occurs in this breed, and then the animal may have varying amounts of white with the body color whatever it may be For the most part, Jerseys have dark-colored muzzles and dark pigmentation around the eyes and unhaired portions of the body Occasionally the tongue and switch of spotted animals are light in color Very rarely do we find a buff-colored muzzle or a light flesh-colored pigmentation about the eyes

The Brown Swiss breed is usually solid colored with black switch and dark muzzle The basic color may vary from a light fawn or mouse color to quite a deep fawn or brownish red If there is white on the body, it is usually on the underline and on the rear flank There is quite frequently a lighter-colored band around the muzzle, though it is not white, and occasionally a lighter strip down the back of the animal

Use size and type to differentiate between breeds The breeds of dairy cattle are usually ranked in size in the following order Holstein, Brown Swiss Ayrshire Guernsey and Jersey There is, however considerable variation between the size of the animals of the different breeds in different sections of the country The Holstein, for instance, is a little smaller in the eastern part of the United States than it is in the central and western states Table 4 1 gives average weights and ranges in weight for both bulls and cows

Not only do we find differences between breeds in size at maturity but also in the birth weights of their calves These latter differences are illustrated in Table 4 1 The size of a calf at birth and the ratio between surface area and weight have a bearing upon the survival rate of the calf When conditions are unfavorable the larger, stronger animals both within a breed and between breeds are a better risk and, other conditions remaining the same are easier to raise

Table 4 2 gives the growth norms for heifers of the different breeds kept in the University of Illinois dairy herd

Type differences can most easily be recognized from living animals or a study of the photographs of superior animals The photographs showing a mature bull and cow of each breed have been carefully chosen by the authors to portray differences in breed type They represent some of the most highly regarded animals of the breed of which they are members The legend under each identifies the breed

Breeds differ in milk composition and yield In milk yield the Holstein is rated first in rank, followed by the Brown Swiss, Ayrshire, Guernsey, and Jersey, in essentially that order It must be borne in mind, however, that there is a large amount of variability in the yield of different animals within a breed, and individuals even of the Jersey breed that are decidedly superior in productive capacity might produce more than low-yielding individuals of the Holstein breed The ratings given are based, therefore, upon general averages for the breeds

Table 4 2 Average Weight of Heifers, Arranged According to Breeds

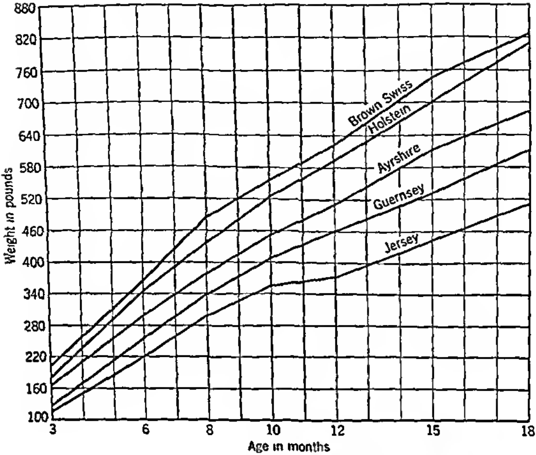

FIG 4 2 Vista Grande King, a highly desirable Ayrshire sire His daughters have good type and heavy production He sold at public auction for $8950

In percentage of fat content, the order is almost reversed, with the Jersey ranking first, followed by the Guernsey, with the Ayrshire and Brown Swiss essentially the same, and the Holstein the lowest Table 4 1 also compares certain other characteristics of the different breeds

These differences in yield and quality of milk are important factors in determining the breed that is best suited for a particular market

The breeds differ rather widely in their value for beef. In the breeds of dairy cattle we differentiate between three different sources of value These are

1 Salvage value for beef
2 Milk production value
3 Breeding value (greatest in registered cattle)

Of these the first is the lowest and quoted on a daily market The second is higher with a general demand The third is highest, but buyers must be located and sales are between person and person

There is some difference of opinion with regard to the beef value of the different breeds of dairy cattle Naturally, the beef value of a dairy animal, just the same as a beef animal, depends to a considerable degree upon its condition In high condition, the Ayrshire probably will kill out the best dressing percentage of any of the breeds of dairy cattle, but the Brown Swiss and the Holstein, because of their size, are also highly prized for their beef qualities, with the highest rank going to the Holstein

The Guernsey and the Jersey rank easily at the bottom of the list, first, because of their lack of size and smoothness, and second, because the fat is decidedly yellowish in color, which tends to identify the carcass in the market

The veal is highly prized and rated superior from the Brown Swiss and the Holstein breeds, with the Ayrshire following as a fairly close third Guernsey and Jersey calves are usually too small and too poorly fleshed to be prized for veal

Special markets can take advantage of breed characteristics. There is a growing tendency for breed associations to take advantage of breed characteristics in developing special markets for their products The most outstanding example is 'Golden Guernsey Incorporated" It was in the early 1920's that the American Guernsey Cattle Club began to ship milk and cream under the trademark 'Golden Guernsey Product" The sale of the special product has grown very extensively

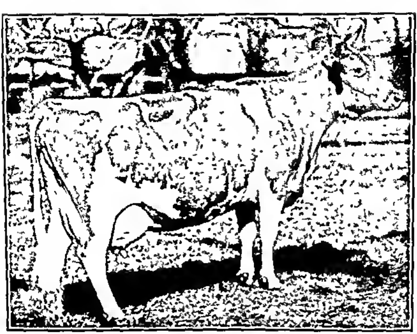

Fig. 43 St. James Philosopher's Barbee, an outstanding cow of the Guernsey breed She has made many large records and possesses the durability and longevity so highly prized in great dairy cows

Jersey Creamline milk is also sold on markets where a high fat, high solids milk is desired.

The lower percentage of fat content of the Holstein breed is sometimes taken advantage of in special baby milk. The milk of the Ayrshire, because of its well-balanced composition, is frequently considered desirable for patients in hospitals and sanitariums and for cheesemaking. Although these special markets utilize a very small percentage of the total production of the breeds, they have considerable advertising value and do aid the individual breeder in marketing his product.

Learn of the native home and early environment of each breed. The Ayrshire breed of cattle originated in the County of Ayr in southwestern Scotland. They are the predominating dairy breed of their native home. They are the only strictly dairy breed that originated in Great Britain.

The Ayrshire is a strongly built, full-chested, and deep-bodied breed and more inclined to freshen up when dry than some of the other dairy breeds. They are considered good grazers, and the carcass value is high for a dairy breed. In general, the cows have shapely, well-attached udders. As a breed they are prized for longevity. The breed is gaining in popularity in the midwestern states.

The Brown Swiss originated in the canton of Schwyz in Switzerland and constitutes one of the two oldest breeds of dairy cattle. The

Swiss breed has for the most part been developed in the mountainous regions of Switzerland spending its summers in the highlands and winters in the lowlands The breed is rugged and seems well adapted to those regions where there is an inclination to transfer from beef to dairy cattle In fact this breed is highly prized in small farm herds The breed has a high carcass value Brown Swiss veal in areas where the breed predominates has preference over the veals of the other dairy breeds

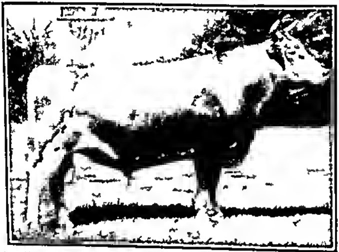

Fig 44 Argilla General Lee a Guernsey bull of excellent conformation He possesses great depth of heart with smoothness and quality

Bulls of this breed are given preference in upgrading scrub herds The solid color general conformation and dairy qualities are generally preserved in first crosses and in subsequent matings

The Guernsey breed originated on the Island of Guernsey which is located in the English Channel The Island is very small in size approximately 16 000 acres of which roughly three fourths is tillable The breed however is well distributed over many countries

The Guernsey breed is especially prized for the golden color of it milk and much emphasis is placed upon this quality in marketing Although the yellow color of milk is highly prized the same colo quality in the body fat is discriminated against in the packing plants and Guernseys have a low rating in beef value The breed has enjoyed great popularity during the past two decades and the sal price of superior purebred animals has consistently reflected thi esteem.

The Holstein-Friesian breed was developed in the former Kingdom of the Netherlands and is now well represented in Holland and Friesland. In origin it is approximately as old as the Swiss, and records indicate the presence of animals of this breed as early as 350 B.C. The breed developed in a country with fertile soils and luxuriant vegetation. It is, therefore, well suited to conditions where good pastures and plenty of supplementary feeds are available.

Cows of this breed, above all other breeds, are cherished for their high level of milk production. This quality has caused the breed to be a favorite in fluid-milk-producing areas. The quantity of their milk production, although the percentage of fat content is relatively low (with a mean of approximately 3.5 per cent), causes the breed to rank high in total butterfat production. The breed also has a good reputation among dairy breeds in beef and veal production, holding top rank in this quality

It is extremely interesting that two of the five major breeds of dairy cattle should have originated on small islands located within twenty miles of each other. The Jersey breed originated on the Island of Jersey, comprising an area of approximately 36,680 acres, not more than two-thirds of the area being tillable. In its native home, this breed was developed to supply a critical group of breeders who wanted an animal of unusual beauty and refinement. In this

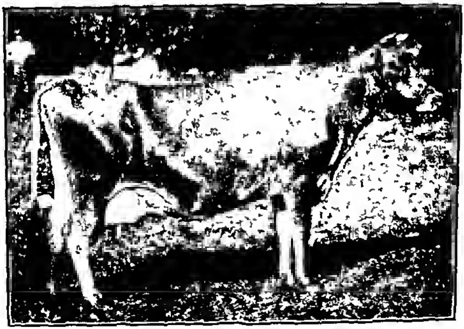

FIG 15. Sociable Sybil, an outstanding Jersey cow She combines excellent type and splendid conformation with high production. She has been many times a grand champion in the show ring

country it has developed into a somewhat larger animal and one well adapted to the warmer climates in the southern states

The breed is highly rated for economy of butterfat production This quality is due to (1) a highly developed dairy tendency combined with the efficient utilization of feed (2) a small animal with a low maintenance requirement in relation to its ability to produce, (3) the high percentage of fat (5 4 per cent) in relation to solids other than fat in Jersey milk

Each breed of dairy cattle is sponsored by an association. A breed association has been organized to support the interests of each breed The major function of each is to (1) provide the facilities for keeping records and protect the interests of breeders of registered cattle, (2) establish programs to test cattle for yield and to evaluate type within the breed (3) promote the breed and provide extension service for breed improvement and development The name, location, and date of founding is given for each breed association

The Ayrshire Breeders Association, established in 1863, is located at Brandon Vermont

The Brown Swiss Breeders Association, established in 1888 has its headquarters at Beloit, Wisconsin

The American Guernsey Cattle Club was established in 1877, with headquarters in Peterborough New Hampshire

The present Holstein Friesian Association, established in 1885 was formed by a union of the Holstein Herdbook Association, organized in 1873, and the Dutch Friesian Association founded in 1882 This association has headquarters at Brattleboro Vermont

The American Jersey Cattle Club was founded in 1868, and is located at Columbus 5 Ohio

Some breeds are characterized as dual purpose cattle The term dual purpose is used to designate those breeds of cattle that are intended for both beef and dairy purposes In such cases the animals are usually expected to give a reasonably large quantity of milk soon after calving and during that period are maintained as dairy animals They are also expected to freshen up readily during the dry period at which time they are somewhat characteristic of the beef form Such breeds have a relatively definite place in agricultural production

Of the dual purpose type perhaps the Milking Shorthorn is the best known The Shorthorn breed has been developed from two points of view The Scotch type is strictly a beef animal but the Milking Shorthorn sometimes called Dairy Shorthorn is kept both

for milk and beef. In England the Dairy Shorthorn is strictly a dairy breed. In the United States, until somewhat recently, the major emphasis has been placed upon beef. The Milking Shorthorn is characterized by a rather heavy flow of milk for several months after calving, after which the rate of decline is rather rapid. When the cow is in the later stages of a lactation and especially when dry, she lays on fat readily and kills out with a very acceptable carcass.

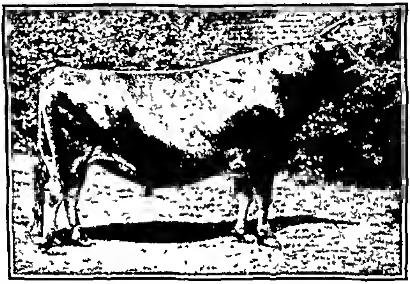

FIG. 46. Fern's Wexford Noble, one of the outstanding Jersey bulls of all time. He was grand champion at many shows

Veal from the Milking Shorthorn breed is highly regarded in the trade.

The Red Poll, another rapidly developing dual-purpose breed, originated in the eastern part of England, probably in the counties of Norfolk and Suffolk. The breed is of medium size, somewhat smaller and finer in bone and generally better in quality than the Milking Shorthorn. The color is cherry red to a deeper shade of red with occasional white areas on the underline. The breed is self or solid in color with a flesh-colored muzzle.

Red Poll cattle are hardy and have the quality of putting on flesh smoothly and evenly when not in heavy milk production. Mature cows of this breed are capable of producing upward of 12,000 pounds of milk testing slightly more than 4.0 per cent butterfat. During the seven years 1946–1952 inclusive, 913 records were made showing an average production of 7632.7 pounds of milk and 318.87 pounds of fat with an average butterfat test of 4.17 per cent.[1]

[1] Data taken from Red Poll News, Jan–Feb, 1953, p 52

There are other breeds of dairy cattle not so well known in the United States Among them might be listed Red Danish, Sunnicathal Red Sindi, as well as minor breeds such as Dutch Belted, French Canadian Devon Kerry etc These breeds although often important in their native habitat are found, if at all in small numbers in the United States

In choosing a breed consider community preference There are several advantages to choosing a breed that predominates in your community Make a survey of the farms in your community or township in order to determine the breed of dairy cattle most commonly found In making your survey learn, if possible, whether or not the breeders are satisfied with the production and characteristics of their cattle Make a list of the criticisms both favorable and unfavorable, that you obtain Ask the dairymen what breed of cattle they would choose if they were again starting in the business Find out if possible, the approximate date of the establishment of the different breeds in your community Discuss with the older dairymen the order in which different breeds were introduced and the reasons for their introduction One of the best guides in agriculture is afforded by the practices of the most progressive and successful farmers in the community It is good judgment, therefore, to consider carefully the breeds selected by the most successful dairymen and their methods in handling them

Select the breed best adapted to the environment and climate Extremely cold and extremely hot climates are alike unfavorable for the production of milk, unless some special provision is made to keep the cows more comfortable than they normally would be The breeds react differently to extremes in climate It is therefore important to know climatic conditions before choosing a breed

If you live in the southern states you will find the summers more or less unfavorable to the larger breeds, notably Holsteins On the other hand, if you are located in the northern states, you will find the larger breeds seem to thrive best Where the climate is not extreme, little attention need be given this factor

While looking up the temperature records learn also the annual rainfall and the period of the year when the moisture is greatest Although the influence of rainfall on dairying is indirect, it is important in that it affects pastures and crops, especially hays, on which the industry is dependent Where roughages are plentiful, the larger breeds, like Holstein and Brown Swiss, thrive especially well

and so are greatly favored Where there is a deficiency of these feeds, the smaller breeds, like Jersey and Guernsey, are more generally found

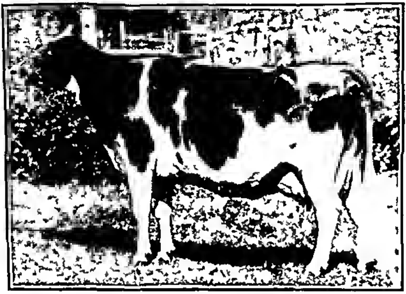

Fig 47 Leedora Man O War Buckeye Echo An excellent Holstein Friesian cow of strong conformation She combines lasting qualities with dairy conformation

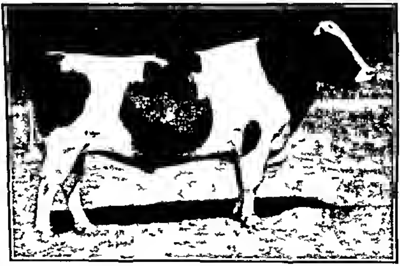

Fig 48 Johanna Rag Apple Pabst As a sire he has exerted considerable influence upon the Holstein Friesian breed He was also grand champion at many leading shows

Consider the market when choosing a breed Where a given type of market prevails, the breed best adapted to the demands of that market is usually found This ordinarily means that the breeds tend to be segregated, one breed being especially numerous where whole

milk is produced and sold and another where there is a market for cream In selecting a breed therefore, a study should be made of the available markets in the community and of the breeds that are best adapted to supply those markets

In sections near our larger cities, almost all the milk produced is marketed in the form of whole milk The same is more or less true in the vicinity of cheese factories or condenseries Where such markets prevail, the higher-yielding breeds predominate, particularly

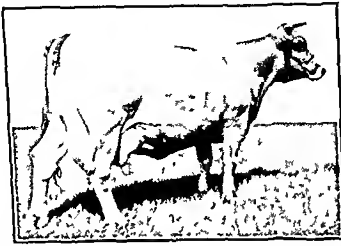

Fig 49 Illini Nellie a Brown Swiss cow of great capacity and splendid conformation The picture shows her making up preparatory to calving After calving she made a world's record for both milk and fat production

the Holstein In these regions the farm operations are centered around dairying, the enterprise that brings in the largest part of the farm income

In sections somewhat removed from our larger cities, and from cheese factories or condenseries, cream or butterfat production is the main dairy enterprise In such regions the herds are usually small, dairying being only a side line, subordinate to other farm operations and bringing in only a minor part of the farm receipts Cows giving milk containing a high percentage of fat are usually favored in these sections where cream is marketed Except in certain northern states, Jerseys predominate for this type of market

When butterfat is marketed, skim milk remains as a by-product on the farm Its principal use lies in livestock feeding, particularly for calves, hogs, and poultry While part of it is generally used for calf feeding, the largest portion is usually available for hog or poul-

try feeding. One hundred pounds of skim milk for hog-feeding purposes is considered equivalent in value to one-half bushel of corn. When corn sells at 1 dollar per bushel, skim milk is considered worth 50 cents per hundred pounds. In feeding for special purposes, such as fitting hogs for show or exhibition, skim milk has a still higher value.

Personal preference is important in selecting a breed. Some dairymen dislike the appearance of a Holstein but develop a great fondness for a Jersey. Others admire the ruggedness and large frame of the Holstein but have a great aversion to the smaller and more refined Jersey. Tastes differ in cattle as they do in clothes, and as the possession of a particular breed may mean much to the pleasure of the owner, he should give consideration to the breed of his fancy.

A dairyman should always bear in mind that utility, adaptation, and productive capacity are the qualities that wear best. Furthermore, there are many more opportunities to cooperate with neighbors if you keep the same breed of cattle. Likewise there is better comradeship among owners of the same breed than among owners of different breeds. But nothing is more important than to have good cattle, no matter what the breed.

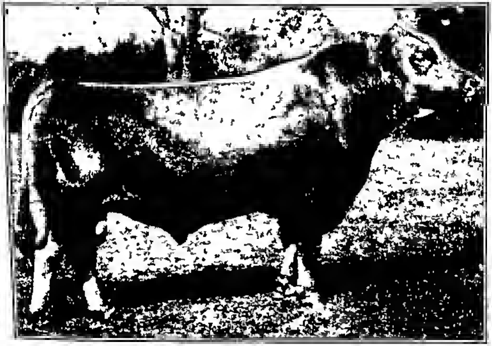

FIG. 4 10 This Brown Swiss bull was Grand Champion at the National Dairy Show. He is an excellent specimen of the current concept, because he possesses size without coarseness and dairy qualities without sacrificing ruggedness or substance.

There is an occasional opportunity to market a special product. Occasionally there are opportunities to supply a product to a special or select market For instance, a demand may be created for the retail sale of a special milk for babies or for unusually rich milk It is sometimes possible to sell sweet cream for ice cream or for some other special purpose

Determine which of the dairymen in your locality market their milk or cream in some special way Compare the prices which they receive with those prevailing in the general market Study the advantages and disadvantages of marketing in this way, and conclude whether or not all breeds of dairy cattle are equally well suited to the requirements of that market

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REVIEW

1 Which is more important to a dairyman the breed he chooses or having excellent animals?

2 Give the body color of the different breeds

3 Rank the breeds in size

4 In what major respects does the milk composition vary between the breeds of dairy cattle?

5 Which three breeds are considered more desirable *for beef?* Name those with a low beef rating

6 Which breed has developed a *special market for milk?* What is the product called?

7 Where did each breed originate?

8 Name and be able to give the address of each breed association.

9 What is a dual *purpose* breed?

10 What factors or items should one consider in choosing a *breed?*

11 Compare the five breeds in age of maturity

12 What are the average yields of milk expected of *each* breed under farm conditions?

5

Examining the Principles of Heredity

Nature has always had laws or disciplines by which she perpetuated a species and prepared it to survive in a particular environment But for centuries man knew very little about nature's program and was bewildered and frustrated in all of his efforts to study the mechanics of inheritance It was about the middle of the last century that an Augustinian monk by the name of Gregor Mendel, working in a garden of a monastery at Brunn, Austria, by application of the experimental method, discovered certain facts about inheritance It cannot be said that this discovery took the world by storm, nor was it, at the time, recognized as being of any particular significance In fact, the world either did not know (the experiment was published in an obscure publication) or did not understand, because Gregor Mendel's discoveries were forgotten for almost half a century

Had it not been for the investigations of three other scientists, working simultaneously but independently, probably the world would have waited a long time for knowledge of Mendel's discoveries The investigators referred to were Correns, a German, Tschermak, an Austrian, and De Vries of Holland These men, since none of them were, at the time, familiar with Mendel's work, actually rediscovered the same laws that Mendel had demonstrated almost fifty years before

It would hardly be within the range of truth to say that had it not been for Mendel's discoveries we would be lacking our present understanding of Mendelism, since the findings of Correns, Tschermak, and De Vries would have started the investigations that for the most part have established our knowledge of heredity By the same reasoning the loss to the world of Mendel's discoveries should in no way detract from the fact that it was, after all, Mendel who was the first to understand certain of the laws of heredity

It is not particularly important to us in our studies now, to review the experiments of Mendel. Even though Mendel made basic and lasting contributions to our understanding of breeding, he did so

without knowing very much about the mechanism of heredity In short in light of our present knowledge, you can have a more complete and well-rounded knowledge of heredity than was available to Mendel

There is a physical basis of heredity The discovery of the compound microscope by Schwann made it possible to learn that the body was made up of very small and somewhat independent units known as cells Further studies demonstrated that these cells differed in form and function Even before the identity of the cell was established it was known that different parts or organs of the body performed different functions but their structure and functions could not be clearly established without the aid of the microscope and other tools of science

The cell is an important structure in inheritance Basically the cell is made up of a substance known as protoplasm This protoplasm may be further differentiated into cytoplasm and nucleoplasm The cytoplasm constitutes the major portion of the cell and is important in growth and as a vehicle to carry the nucleus The nucleus is a small, differentiated bit of protoplasm and contains the chromatin material vital to reproduction and growth

A large number of differentiated cells are grouped together to form the reproductive system of the animal Such cells and groups of cells generally appear to be beyond the influence of external factors and therefore more or less immune to environmental effects In short, the germ plasm or reproductive cells of an animal are not changed by the external influences to which the animal itself may be subjected This point is important in heredity

Reproductive organs not subject to environmental influences Early in the life of the embryo of any species certain cells are set aside that are destined to perpetuate the race Although such cells may have secondary functions—such as secreting hormones, substances that influence the development secondary sexual characteristics, etc , of the individual—their primary function is that of reproduction Such cells are independent, from an hereditary standpoint, of the body cells and are not influenced in their transmission of hereditary characters by conditions which might, and often do, have a lasting effect on the body cells of the animal This very fact is highly important in preserving the identity and specific nature of the characteristics of an individual

The determiners for milk production and type are located in two reproductive cells. All of the genetic characters that make up the

animal are conveyed to it in these two minute reproductive cells The single units that control a particular character such as spotting, body color, horns, congenital cataract (blindness), and many other characteristics in cattle are so minute that they can only be seen by the use of the most powerful microscope Such units (called genes by geneticists) are tied together in chain-like or rod-like formations These chains (chromosomes) are the smallest separate units that segregate freely when the new sperm and ovum are being formed in the reproductive tracts of potential parents

Each species has a definite number of these chain-like units All but one of these occur in pairs in both sexes In cattle one member of a pair has been received from the bull and the other member from the cow When these chain-like units at fertilization unite to form the new embryonic calf, all of the heritable characters are carried from parents to offspring Therefore, essentially one-half of the characteristics of an offspring come from the male parent and the remaining one-half from the female

The entire genetic contribution of the male is contained in the single cell called a sperm In the mating process, whether it be natural or by artificial service millions of sperm cells are introduced into the reproductive tract of the female, for it is a responsibility of the sperm cells to locate the ovum (reproductive cell of the female) and unite with it This contact must be made and fertilization must result before a new progeny can come into being In the reproductive mechanism, nature could not rely on one male cell to carry out this important mission, so she created millions of them, each one capable of kindling a new being if it happened to be the particular sperm that made first contact with the ovum

In the cow, except in very rare instances, one ovum only is produced following each oestrus In two or three cases out of each hundred, two ova are produced If both are fertilized, and usually they are, twin calves are produced

Only a single sperm can fertilize an ovum. Only one sperm from among all of the millions that start in this search for the ovum can be successful When a single sperm penetrates the cell wall of the ovum, a protective membrane is set up and no other sperm can enter This is important because the two cells (sperm and ovum) are fashioned to carry all of the hereditary components necessary for the new individual The authors are not aware of a case in cattle when for some reason the protective mechanism has failed and two sperm have entered the ovum The degree of effectiveness with which

nature has set up this protective mechanism is one of the many wonders of reproduction

Genetic improvement is made by creating new generations When a sperm and an ovum fuse in the process of fertilization a new life has been kindled This single-celled new being is at this stage known as a zygote This tiny cell, although so small that a microscope is required to view it possesses all of the hereditary qualities that will develop in the new individual and some that will not be visible but were possessed by the race from which it came

With the formation of the zygote by the union of a particular sperm and a specific ovum the hereditary die is cast and no genetic change thereafter is possible The next change in heredity, if there be any, will occur when the zygote having grown to maturity, reproduces its own germ cell (sperm or ovum) The very essence of the genetic change that can be brought about in cattle by a breeder lies then, in his choice of which ovum and what kind of sperm will have an opportunity to fuse together This he does by choosing the parents that are to produce the next generation

Study carefully the basic laws of inheritance The genes are the bearers of hereditary determiners, and they are fastened together on rod like forms known as chromosomes This may be a protective measure that nature has used to prevent the loss of so minute a bit of protoplasm as a gene in the complicated *process of reproduction* The genes that are held together on a single chromosome are said to be linked together, and the characters which the genes transmit are held to each other by linkage *Therefore* the characters which they transmit appear together and when one is found the others *are* present

Gene influence tends to remain constant An animal lives, reproduces, and dies, but as long as any of its descendants survive, many of its characters are perpetuated Furthermore, if a particular gene is conveyed *to* progeny, or even a combination of genes, the characteristic which it or they transmit remains essentially the same as it was in the original parent Perhaps this characteristic of gene action can be more clearly portrayed by an experience of one of the authors when he visited an old cathedral in the city of New Orleans

Between the front row of seats and the altar there was *located* a huge old hand wrought candelabra with several large and very long candles burning on it Under *each* candle was a cone shaped pile of tallow, evidently formed by the drippings from the burning candles The impression that one got from looking at these candles was that they had been burning a long time The caretaker verified this point

are held rather tenaciously on chromosomes Heredity is, therefore, a natural process controlled by a delicate mechanism that obeys certain laws There is no better method by which to study the workings of this mechanism than to apply it to certain characters in cattle

Chromosomes segregate with complete freedom Technicians are not in complete agreement on the number of chromosomes that are contained in the reproductive cells (sperm and ovum) of cattle The more recent and according to the majority of research workers, the most valid studies were made by Krallinger (1931) and Makino (1944) These workers are in agreement that cattle have sixty chromosomes or thirty pairs one member of each pair having been received from the sire and the other from the dam

There is a character sometimes found in Holstein cattle that is currently causing Holstein breeders a good deal of concern It is the red factor or red and white color, instead of the normal black and white spotting The concern referred to arises when a bull carrying this character is used extensively in artificial breeding The problem arises when two black and white parents have a red and white offspring

The explanation is relatively simple Obviously the character red and white is in the recessive form Black and white being dominant, masks or overpowers the recessive condition (red and white), therefore the latter does not appear, and the animal is black and white Table 5 1 explains by the use of symbols *B* for black and white and *b* for red and white, how this character is inherited This explanation applies if both parents although black and white in color, carry the red and white factor in the recessive condition

Test black and white bulls for the red factor by mating them to red and white cows Young bulls that are to be used in artificial breeding should be tested for the red factor This is easily done by mating them to red and white cows If a single red calf is born to such matings it is known that the bull is heterozygous for black and white i e he carries the red factor If, on the other hand he has sired ten or more calves without having had a single red and white offspring then the odds are heavily in favor of his being pure or homozygous, for black and white Under such circumstances he may be used with a high degree of probability that he will not sire red and white calves

Many unit characters have been demonstrated in cattle It is desirable to become familiar with these unit characters in cattle Many of them are now coming to have a highly important place in

Table 5 1 How Black and White Parents Can Produce Red and White Offspring

B = Symbol for black and white (dominant condition)
b = Symbol for red and white (recessive condition)

Explanation	Bull	Cow
Parents' color	Black and white spotted	Black and white spotted
Kind of reproductive cells (gametes) parents are capable of producing	Sperm B or Sperm b Produced in equal numbers	Ovum B or Ovum b May be either type, not both
Kind of offspring these parents can produce	BB = black and white (pure or homozygous) Bb = black and white (heterozygous like their parents) bb = red and white	
Ratio of black and white to red and white offspring from heterozygous black and white parents	3 Black and white	to 1 Red and white

cattle breeding programs This is especially true for lethal[1] or semilethal characters Such characters can be widely introduced into a cattle population by bulls used extensively in artificial service Table 5 2 lists most of the known unit characters in cattle A separation is made between those characters that are presumably harmless and those that are lethal or otherwise objectionable

Table 5 2 Unit Characters in Dairy Cattle

NOT DEEMED HARMFUL TO AN ANIMAL WHETHER IN THE DOMINANT OR RECESSIVE CONDITION

DOMINANT CONDITION	RECESSIVE CONDITION
White	Colored
Black color	Brindle yellow or red
Color sided	Uniformly colored
Black and white spotted	Red and white spotted
Switch black	Other color white
Tongue pigmented	Tongue clear
Polled	Horned

[1] A lethal character is an inherited trait that produces the premature death of an animal under conditions that a normal individual would survive

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[1] A lethal character is an inherited trait that produces the premature death of an animal under conditions that a normal individual would survive

Table 5 2 Unit Characters in Dairy Cattle (Continued)

UNDESIRABLE BUT NOT LETHAL THE UNDESIRABLE CONDITION WHETHER DOMINANT OR RECESSIVE IS INDICATED BY ASTERISK

DOMINANT CONDITION	RECESSIVE CONDITION
Eye normal	Congenital cataract *
Hernia, umbilical (sex limited) *	Normal
Dexter (short legs) *	Legs normal
Udder, 2 quarters on a side	Udder 1 quarter on a side *
Normal face	Wry or twisted face *
Normal jaw	Undershot jaw *
Ear, notched *	Ear, normal
Tail, normal	Screw tail *
Tailhead normal	Wry tail (tailhead to one side) *
Polydactylism (extra toes) *	Hoof, normal
Normal hoof (2 toes)	Syndactylism *
Normal size	Dwarfism *
Normal pasterns	Flexed pasterns *
Normal hair (straight)	Curly hair (karakul) *

LETHAL TO THE INDIVIDUAL OR TO THE SPECIES

Almost all lethal (death producing) characters are recessive, that is, they are produced by apparently normal but heterozygous parents.

NATURE OF DEFECT	CHARACTER IDENTIFICATION
A defect of the skeleton, of endocrine origin. Calves usually die in early months of gestation and are aborted	Achondroplasia 1
Characterized by a short head, cleft palate, and extremely deformed jaw Calves usually die soon after birth	Achondroplasia 2
Skin defect facilitating infection and ultimately death occurs due to septicemia	Epitheliogenesis imperfecto
Sometimes characterized as sublethal in that individuals may live for a considerable period Not as severe as 1 and 2	Achondroplasia 3
Individuals have no jaw or very imperfectly developed jaws (may be sex limited to males)	Agnathia
Such calves have no appendages at all or only to knees and hocks Also jaw defect Die at birth or soon after	Amputated
This gene produces ossification of jaw and shortening of the jaw bone Animals born dead or die soon after birth	Ankylosis
Affected animals have an accumulation of fluid in the subcutaneous and in the thoracic	

Table 5.2. Unit Characters in Dairy Cattle (Continued)

NATURE OF DEFECT	CHARACTER IDENTIFICATION
and abdominal cavities, especially in anterior portion of body. Dead at birth or abortions.	Congenital dropsy
This gene produces hairlessness except eyelids, muzzle, ears, and switch. *Infected animals* usually die at birth or soon after.	Hypotrichosis congenita
Infected animals are born alive but die soon after birth. Hind legs especially are involved. Animals cannot stand alone.	Lameness
Death usually occurs in the eighth month of pregnancy. Such aborted animals have short necks, stiff legs, and enlarged joints.	Mummification
Animals are born with front and rear legs drawn together and up against body. Joints are rigid. See Figure 5.1.	Muscle contracture
The backbone is very short; other parts of body appear essentially normal. Calves are sometimes born alive but die soon after birth.	Short spine
Animals born alive but show spasmatic muscular contractions. Animals usually die within a few weeks after birth.	Spasms

FIG. 5.1. This purebred Shorthorn calf was one of six born on the same farm. All died at a few weeks of age. This calf could not stand alone, and it was not possible to straighten the legs. Muscle contracture is due to a *single gene* in the recessive state.

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REVIEW

1 Who was Gregor Mendel? What did he do?

2 What is the physical basis of *heredity*? *What are germ cells?*

3 Are reproductive organs subject to environmental influences?

4 *Of which is there* a greater number, *sperm cells or ova?*

5 How many sperm cells enter the ovum?

6 How is genetic improvement achieved?

7 Does the influence of a particular change from *generation to generation*?

8 How do animals grow?

9 Discuss the *relation of genes and chromosomes* Do chromosomes segregate with complete freedom?

10 *How* is the character red and white inherited? How can we test a bull to determine whether or not he can transmit red and white?

6

Employing the Principles of Heredity in Dairy Cattle Improvement

Man is gradually becoming able to understand that, under nature's laws of reproduction, the individual constitutes but a link in the great chain of species existence. It is, therefore, only by producing progeny that the individual can make any contribution to posterity. As has been pointed out in Chapter 5, it is the germ plasm, not the individual, that has an abiding influence upon the race. The individual as such is not perpetuated; it is the germ plasm which he or she is custodian of for a time that provides the bond between generations. This is perhaps the wisest provision of nature and supplies man with some of the tools which he needs to change the genetic character of a population.

Yield of milk is a response action. The yield of a cow for any given period, whether expressed in terms of pounds of milk or pounds of butterfat, is determined by the interplay between two major factors, heredity and environment. Environment, a general term including all of the conditions under which an animal is forced to live, is alone responsible for all the increases or decreases in production that may be effected in animals now living. It should be clearly set forth here, also, that such environmental factors as feed (both qualitatively and quantitatively calculated), climatic conditions, seasonal influences, management, health of animal, etc., are all significantly important in establishing the yield or level of production of animals with different hereditary capacities. The best hereditary talents for production cannot, therefore, find expression without favorable environmental opportunity. The production or yield of a cow for a lactation is a response, a reaction to her opportunity (environment) conditioned by her potential (inherited ability).

Inheritance determines the potential capacity of the cow. In cattle it is good inheritance that provides the animal with the competence or capacity to yield large amounts of milk and butterfat. Inherent capacity in the cow is much like horsepower in a car for it provides

the ability to accomplish a given amount of work In the cow this is the capacity to transform large amounts of the energy obtained from feed into the energy of milk

The horsepower of a car should seldom if ever be used to its maximum capacity To do so is dangerous to the operator and to the future and life of the car There is built into the car by the manufacturer a certain level of operational efficiency, and the car functions best and longest if operated at the intended speed Increasing the horsepower of the car raises the level or point of maximum efficiency of operation and increases its potential speed

It is much the same with cows If the cow has inherited from her ancestors the ability to eat large amounts of feed and therefore yield a large quantity of milk she is a competent dairy animal But this potential or ability is not a guarantee of production Production results when the animal with good inheritance is given a favorable opportunity, and the level or amount of her production is determined by her ability to respond to that opportunity Cows seldom produce at their maximum capacity even for short periods of time Like the automobile, their optimum and most efficient production is below their maximum capacity But cows with the best inheritance on the average produce the largest yields and have the greatest efficiency in production

Inheritance of milk yield has been proved experimentally. The University of Illinois in 1919 purchased all the animals then living that had been produced in the "Bowlker" breeding experiment, first begun in 1911 by the late T J Bowlker of Framingham, Massachusetts These animals were moved to the University of Illinois and continued in a long-time breeding experiment Many points regarding the inheritance of such characters as milk and fat yields and percentage of fat content, then unknown, have been clarified by this and other experiments

It was found, for instance, that when cows of the Holstein breed were crossed with bulls of the Guernsey breed, the resulting offspring produced a yield of milk approximately halfway between that of their Holstein and Guernsey parents The results were essentially the same in crosses that were made reciprocally, that is, when Guernsey cows were mated to Holstein bulls Table 6 1 gives the actual values, determined chemically, for F_1 and F_2[1] progeny for

[1] F_1 progeny are created by mating a purebred parent of the Holstein breed with registered parent of the other breed F_2 progeny were produced by mating F_1 progeny together

Table 6 1 Inheritance of Certain Constituents of Milk—Bowlker Hybrid Herd

Breed Identification	Constituents of Milk—Expressed in %			
	Fat	Protein	Lactose	Ash
Guernsey parent	5.033	3.920	5.100	0.7540
Holstein parent	3.413	3.101	4.918	0.6836
F_1 generation	4.352	3.429	5.007	0.7314
F_2 generation	4.247	3.511	4.989	0.7189
Expected, based on theory of inheritance	4.223	3.510	5.009	0.7188
Deviation from expectation in F_1 generation	+0.129	−0.081	−0.002	+0.126
Deviation from expectation in F_2 generation	+0.024	+0.001	−0.020	+0.001

the major constituents of milk, namely, fat, protein, lactose (milk sugar), and ash (total soluble and insoluble) Chemical determinations could not be made on the milk of all the parents Those available were used, but in some cases average analysis of the milk of related animals of essentially the same productive level were used to obtain parental averages

In all of the constituents, save only lactose, there is a rather wide deviation between the parent breeds in the average values for each character studied The F_1 and F_2 progeny deviated very slightly from the expectation of mid-value between the parental breeds This experiment supported the theory that percentage of fat content and other constituents of milk are inherited as a result of the combined action of a number of genes

Milk yield followed the same inheritance pattern The Holstein cows used in this experiment at the average age of 2.8 years on two times per day milking yielded 7673 pounds of milk The Guernsey cows produced under the same conditions 4617 pounds milk The F_1 progeny of these females produced 6412 pounds milk Making no adjustment for a differential in the transmitting ability of the sires used, the expectation would have been a yield of 6145 pounds milk Actually the yield was 267 pounds milk above expectation This small deviation could be accounted for in several ways, such as sires slightly better than the cows with which they were mated, heterosis or hybrid vigor, etc The fit between the actual and expected production was extremely close, and the observations warrant the conclusion that milk yield is transmitted as a result of the combined effects of genes, with several genes contributing to the

inheritance Other similar experiments conducted at about the same time in Wisconsin and Maine have yielded somewhat similar results

Milk yield potential is determined by the cumulative and inter action effect of many genes Among the first to attempt to explain the inheritance of milk production was James Wilson in his book Principles of Cattle Breeding He concluded that one or two genes were all that were responsible for the inheritance of milk yield W E Castle working with rabbits concluded that several genes were involved in determining head size Many other experiments have revealed that Castle s concept was correct and that there is a large group of characters that are inherited as a result of the combined influence of a rather large number of genetic factors Such char acters in dairy cattle are size of animal milk yield percentage of fat content conformation of animal etc Characters of this type do not ordinarily show dominance or recessiveness as unit characters do but are inherited as a mid value between the two parents For example if milk yield is the character considered and one parent can transmit an 8000 pound capacity to yield milk whereas the other parent transmitted 12 000 pounds the offspring of these parents would on the average with opportunity the same be expected to have a 10 000 pound milk production ability The offspring would al o be assentially intermediate between the parents for all char acters inherited in this way

In multiple factor inheritance gene influence is mostly additive If you have been a boy scout and observed or participated in a tug of war you know that it takes the combined effort of some six to ten different individuals all pulling on the same rope at the same time to constitute a team In this game each boy exerts a certain pull or adds his increment of power or draw to the rope Boys of different sizes and strengths exert a different amount of pull but the sum of the pulls of each boy *no matter what it may be* determines the total pull Similarly by analogy several independent factors or genes all contributing perhaps different amounts to the same character (let us for example assume milk yield) determine the capacity of the cow to produce milk We should also remember that the heredi tary capacity of the cow and the actual yield of milk may not be the same because the environment or opportunity is likewise very important in determining the actual yield It is just as important

[1] Castle William F Heredity n Relation to Evolution and Animal Breed ing 1911 (Appleton)

in fact, as the footing or training of a team in determining the amount of their combined pull in a tug of war

In multiple-factor inheritance dominance, epistasis, and overdominance may also influence production and type. It would be unfair to assume that the inheritance of complex physiological characters such as milk yield or size is a simple process or easily explained Although, as has been stated, the majority of the inheritance of the average herd can be accounted for by the additive influence of many genes, other types of inheritance may have a part in the process

Dominance. In Chapter 5 we studied how dominance influenced the behavior of a single gene in the unit character color Dominance can also influence the inheritance when several genes are involved Let us assume that the genes A, B, C, and D influence milk yield and that the following condition exists in the germ plasm content of a bull, namely, $AABBccdd$ This bull is then mated to a cow with germ plasm described as $aabbCCDD$ The germ plasm of the progeny would then be $AaBbCcDd$ Since A is the dominant condition, two doses (homozygous condition) have no more influence than one dose Therefore Aa is as effective in determining the production potential as AA The same would apply for the remaining genes B, C, and D Therefore a daughter produced by the two parents indicated above would, insofar as the influence of dominance applies, inherit more productive ability than either parent possesses

Epistatic effects. In breeding experiments results have been obtained and ratios have been produced which cannot be explained by the influence of simple dominance Such results have been observed in plants and in several different classes of animals Bateson used the term epistasis to explain the occurrence of certain of his unanticipated experimental results

The term epistasis is now used to explain intergene action when the genes occupy different loci (positions) on the same chromosome or are located on entirely different chromosomes This influence may be in the nature of dominance, partial dominance (intermediate condition), or recessiveness, or it might take other forms

It is unlikely that epistatic influence assumes any great importance in cattle breeding unless inbreeding or line breeding is extensively practiced

Overdominance. If in certain matings the progeny are better than either parent, which infrequently occurs, the condition is sometimes explained as overdominance Overdominance is of special interest in explaining the occurrence of heterosis (hybrid vigor) A simple

explanation of overdominance would be that if Aa produced a greater influence upon a character than AA, then overdominance would exist. A rather fine line exists between an epistatic effect on a character and overdominance for the character, the principal difference being where the effect originates on the chromosome.

Of the various methods nature has for contributing to the inheritance of such characters as milk yield, fat percentage, body conformation, size, etc., she relies more on the additive method and dominance than upon epistatic effects or overdominance. The latter two might, however, be highly important in certain matings and in certain systems of breeding.

Milk yield is not solely heritable. There is a great tendency on the part of many to conclude that a cow's record measures exactly the amount of milk or fat-producing ability that cow is capable of transmitting to her offspring. What actually has been measured, as was emphasized earlier in this chapter, is the ability of the cow to respond to a particular environment. If the environment is changed in any way, the record will be somewhat different. The problem is to find how much of the response is the result of environment and how much is due to hereditary influences. This latter point is at the moment of special interest to us.

Those who have made the most penetrating studies into this question have found that approximately 30 per cent of the difference between production records is due to the influence of inheritance. Therefore we may further conclude that the change which is made between generations is on the average 30 per cent heritable. This applies for such characters as milk yield, size, type, butterfat yield, etc.

How does selection work in changing the characteristics of cattle? Any selection that is effective in changing the genetic character of cattle must substitute one kind of germ plasm for another. If low yield is to be changed to a higher level of production, then the germ plasm that was responsible for low yield must be exchanged in some fashion for germ plasm of a higher order of production. In short, something bad must be eliminated before anything good can be substituted to take its place. Such changes in germ plasm can only be made when creating a new generation. Consequently, the simplest form of selection is the elimination of the most undesirable germ plasm. This is accomplished by preventing such germ plasm from reproducing.

Select for improvement within a herd The choice between the characteristics that will be retained and those that are to be destroyed or discarded in any herd is the problem of the breeder In order to eliminate undesirable germ plasm some animals must be sacrificed or their reproductive influence on the herd curtailed This process is usually carried out within the herd We sometimes speak of it as "culling" The steps that are used in this process are

1 The breeder determines the yield of each cow in his herd by keeping production records

2 He decides that some cows are producing too little milk and fat to be permitted to have more progeny in his herd

3 He either disposes of these cows (probably for beef), or he decides to keep the cows but not to grow any progeny from them Either of these two decisions if adhered to has the same influence upon the genetic condition of his herd

4 When he reduces by this process the amount of undesirable germ plasm in the cows retained in his herd, he has begun one phase of an upgrading program

Give the best germ plasm preference when keeping heifers If it has been demonstrated that the genetic qualities of the animals within a herd differ, then animals with the least desirable germ plasm should be eliminated That is usually the first step in genetic improvement But, concurrently, the best germ plasm should be given a greater opportunity to be perpetuated This is accomplished by saving for breeding purposes a higher percentage of the progeny from the best animals If we assume that it requires 60 per cent of the females born in a herd to maintain numbers, then we should save, insofar as possible, that 60 per cent from the upper or better part of the herd

Introduce superior germ plasm from another herd It is conceivably possible, especially in a large herd, that, by a long and rigidly applied selection program, one could ultimately produce a few animals that were decidedly better than anything previously found in the herd To do this would no doubt require many generations of animals and a long period of time If, on the other hand, animals of superior quality can be located and purchased, their genetic value is quickly available for herd improvement The introduction of such superior germ plasm is usually accomplished through sires This is logical since the sire's influence is repeated so extensively in a herd Artificial insemination has excellent potentialities for this type of selection influence, especially for the breeder with a small herd

Use all selection measures at one time All three of the above selection measures namely, (1) culling out the poor germ plasm (2) giving the best germ plasm in the herd greater opportunity for perpetuation and (3) bringing to the herd superior germ plasm from other herds, operate on the principle of substituting something more desirable for something that is less wanted This is a good program to follow and if nothing else were to be done in time there should be definite within herd improvement But a breeder does have more tools to work with

Become familiar with the systems of breeding Systems of breeding or programs for mating animals are in a way tools to facilitate the accomplishments of a breeder They have no effect upon the mechanism or physical basis of heredity They do not regulate Mendelian inheritance or change any of nature's laws for perpetuating characters But they can accelerate or reduce the speed with which certain objectives can be carried out They can be quite potent agents also in bringing to light or covering up certain qualities in a herd Their value depends largely upon the intelligence of the breeder and the understanding he has of the consequences of their use

In general, the systems of breeding accomplish one or the other of two things They either (1) create greater homozygosity within a population accomplished by inbreeding or (2) cause greater heterozygosity by introducing outside genes accomplished by outbreeding Breeding is therefore either in or out and the objectives and accomplishments are quite different

Use inbreeding to fix desirable characters Inbreeding consists of mating animals that are more closely related to each other than the average of the herd or breed from which they come The breeder chooses inbreeding in preference to outbreeding or random mating if he wishes to fix the highly desirable characteristics of his own superior herd Certainly he should not use inbreeding if his herd is below the average of the breed It should be obvious that no good purpose is to be served by purifying poor germ plasm or germ plasm leading to low production

Since self fertilization is not possible in cattle the closest or most intensive inbreeding that can be attained is by mating full brother and sister or parent and offspring The degree of inbreeding is reduced markedly when first cousins are mated and there is practically none at all when second cousin or less relationship is present in the parents

The term line breeding is commonly used among breeders who practice half-brother and sister or cousin to cousin matings. Genetically line breeding is simply a *mild form of* inbreeding. True, it does accomplish some of the purposes of inbreeding, and, at the same time, is less likely to bring heterozygous recessive characters to the homozygous condition as frequently or as surely as inbreeding. Homozygous recessives can become a serious breeding problem in some herds.

It should be made clear that inbreeding instead of making a herd more uniform in appearance may expose new characters not previously found. Therefore, in order to take advantage of inbreeding to create a more uniform breeding herd, it is necessary to practice selection. By selection gene frequency can be changed, more good genes can be incorporated in the inheritance, and objectionable genes can be culled out. This is accomplished by dropping out of the breeding program animals that show unwanted qualities and keeping those that possess the desired traits. By the wise use of inbreeding and selection, a herd can become more nearly uniform and better.

Inbreeding can pose serious breeding problems. In the average herd inbreeding is not likely to become a helpful breeding system. This is true because the germ plasm in such herds has been derived from many different sources and includes many hidden undesirable characters, in recessive form, which inbreeding will bring out. Thus the losses may be greater than the gains if it is used. Some of these characters are (1) reduced fertility, (2) complete sterility, (3) lethal characters, and (4) physical defects.

Reduced fertility or sterility. Animals must reproduce normally to be profitable. One of the examples most often referred to of the success of inbreeding in improving type is the Duchess family of beef Shorthorns. Intensive inbreeding was used in developing this family, and fertility was sacrificed in the program. Figure 6.1 illustrates just how many animals were either sterile or shy breeders among the progeny produced in this way.

When finally the animals that were of superior type and still fertile in this inbred family were outcrossed to unrelated animals, normal fertility appeared to be restored. Much of the type improvement accomplished as a result of inbreeding was also retained. Furthermore, the production of superior beef animals in this fashion established a standard of goodness which no doubt played an important part in creating the improved type of Shorthorn that popularized the breed.

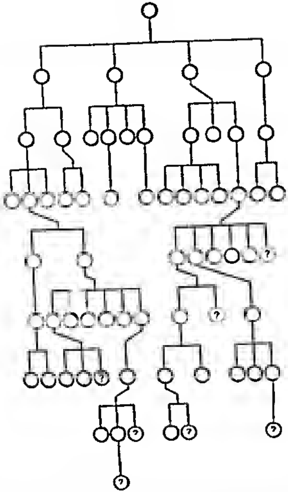

Fig 61 Of a total of 67 females in this family 25 were reported to be barren These are indicated by the dark circles and 7 indicated with a question mark were doubtful cases Therefore almost one-half of the females were either sterile or doubtful breeders

What should the average breeder do about inbreeding? A consequence of making a herd more homozygous is to bring to light many recessive genes not previously known to exist in the herd Recessive genes are usually less desirable than dominant genes are, therefore inbreeding more frequently than not results in a deterioration of merit among the individuals in the herd Consequently, the breeder who wishes to use inbreeding should (1) analyze his herd for qualities of excellence and come to the decision that more than anything else he wishes to concentrate and purify those characters (2) He should carefully analyze the inbred progeny in his herd for evidence of new

undesirable qualities not previously observed (3) Based upon his observations he must decide whether the good being accomplished by inbreeding outweighs the objectionable qualities uncovered by its use (4) Even if he decides against inbreeding he should understand that some of his best inbreds may be highly useful in outcrosses

Outbreeding tends to create a heterozygous population. Outbreeding has a rather good reputation among livestock men It is credited with contributing[1] to vigor, fertility, heterosis, size, etc Actually what outcrossing accomplishes more rapidly than random mating is the creation and maintenance of a highly heterozygous herd or population

Since the dominant condition is usually more desirable than the recessive state, the initial results of outbreeding are favorable The added new genes which outbreeding introduces into the herd, however, increase the variability after the first generation and tend to make the herd less uniform both in appearance and performance

Outbreeding is a relatively safe program to follow (1) if the average quality of a herd is below that of the average for the breed, (2) if it is desirable to prevent objectionable recessive characters from making an appearance in a herd, (3) if the upper quarter of the herd does not include a number of highly desirable animals, and (4) if the breeder is content to have a herd that hovers about the breed average

It should be emphasized that when outbreeding is continuously used in perpetuating a herd, the average quality of the herd tends to fluctuate about the average or mean of the breed

Crossbreeding is an extreme form of outbreeding. Crossbreeding is accomplished when a bull and cow are mated, both of which are purebred but belong to different breeds More specifically the progeny resulting when a Holstein bull is mated to a Guernsey cow would be termed crossbred. Crossbreeding is frequently practiced in swine, poultry, and sheep, less frequently in beef cattle and very little in dairy cattle.

Genetically, crossbreeding produces an heterozygous condition Crossbreds themselves are not any more variable than were the parent races from which they came The individual merit of crossbreds may be quite high largely due to dominance Their progeny, however, tend to be more variable than they are themselves

[1] Outcrossing is the mating of individuals of different strains In livestock such matings are made between unrelated or slightly related animals within the same breed

Most of the crossbreeding done in dairy cattle has been (1) to study the behavior of genetic characters in heredity Crossbreeding made it possible to observe the widest differences such as percentage of fat content of milk when Holsteins (3 45% fat) and Jerseys (5 4% fat) were mated, or (2) to quickly correct a problem situation, for example, if milk is rejected on a market because of low fat content, this situation can be improved by using a Guernsey or Jersey bull on

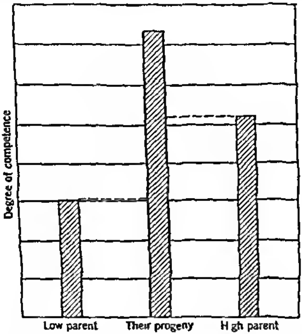

FIG 6.2 In this case the offspring is superior to the better parent

Holstein females and keeping the female progeny for herd replacements More recently crossbreeding has come into popularity because of the success of hybrid corn

Heterosis or hybrid vigor is associated with crossbreeding Heterosis, sometimes called hybrid vigor, might be simply defined as the superiority of a progeny over its better parent It can be illustrated by a simple graph (Figure 6 2) A more thorough analysis of the problem is shown in Figure 6 3 Some experiments have been undertaken to determine how significant or important heterosis may be in dairy cattle breeding Until the results of these research studies become available and a practical program based upon the findings can be formulated, it appears unwise to hold out too much hope for or to strongly recommend the crossbreeding of dairy cattle

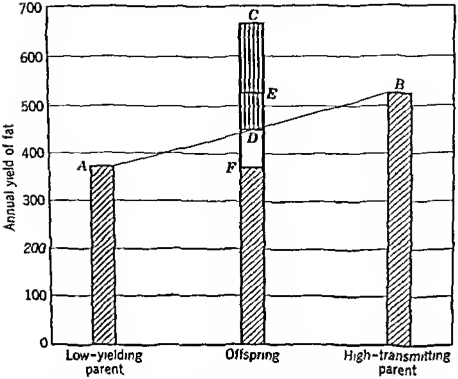

FIG 6.3 Point *E* on the offspring scale indicates the level of production of the high transmitting parent, and point *F* indicates the yield level of the low yielding parent Point *D* is the mean, or what the yield would be if both parents contributed equally to their offspring The area from *D-C* is additive production and is due to the effect of dominance epistasis overdominance, etc This additive difference is also referred to as heterosis (hybrid vigor) The figures used are for demonstration purposes and have not been taken from an actual experiment

Upgrading is good breeding practice. A dairyman with a below-average herd that he wishes to improve by breeding can make good use of the principle of upgrading, sometimes referred to as "grading" or "grading up" The purpose of upgrading is to increase productivity, develop uniformity, and improve the quality of offspring These objectives are accomplished by using purebred sires on native or low-grade dams If good sires are used, especially if the quality of the sire is improved with each generation, progress is generally rapid

The amount of improvement that can be made by an *upgrading* program depends upon such factors as (1) the level of production in the herd when the program is inaugurated, (2) the genetic competence of the bull used in comparison to the inherent capacity of the herd (the greater the difference, other factors remaining the same, the more improvement there will be in the daughters over their dams), (3) the opportunity given the herd to produce (feed and care)

In an extremely poor herd, if the bull transmits well above the breed average and the herd is properly fed and well managed, upgrading is very rapid

At the Iowa State Experiment Station very low-producing native cows were mated to purebred sires of several different breeds of dairy cattle The first generation produced 44 per cent more butterfat than their dams The second generation with 75 per cent of the inheritance derived from purebred sires produced 106 per cent more fat than their native grandams In this project, after four to six generations of the use of purebred sires of the same breed on the native cows, it was difficult to distinguish between many of the grade animals produced and purebred animals of the same breed

Upgrading, if artificial insemination is available to the dairymen, is a simple process One of the most important contributions of the artificial breeding movement to dairy cattle breeding is the upgrading program, it has thus been made readily available to the average dairymen

The sire problem The choice of a sire in any herd, or for an artificial breeding unit, involves the most important decision that is made to promote the effective operation of either organization In the herd the germ plasm of the sire is repeated every time a calf is born to his service In the one sire herd, after two years of service, a sire will have essentially as many daughters as there are cows in the herd His influence is then as great genetically as the combined inheritance of all of the cows in the herd Under artificial service during an equal period a sire's genetic influence may be equal to that of several thousand cows It is, therefore, extremely important to correctly evaluate the genetic potential of a sire Perhaps the best evidence is provided by progeny testing

Evaluating a sire by the progeny test Bulls except in extremely rare cases[1] do not yield any milk Consequently, there is no direct method of measuring their milk-yielding potential The evaluation of the bull must, therefore, be indirect and ascertained in terms of the performance of his progeny

This has been done experimentally with laboratory animals Goodale[2] as early as 1938 was able to increase the average body weight of white mice from approximately 25 5 grams to 35 grams

[1] The famous Guernsey bull King of Chilmark secreted a very small amount of milk from his rudimentary mammae

[2] Goodale H D A Study of the Inheritance of Body Weight in the Albino Mouse by Selection J of Heredity 29 101 1938

His results compared the first 500 mice with the last 500 mice produced in his experiment The total number of mice included in the experiment was about 7000 This gain in weight represented approximately 37 per cent and was accomplished largely by sire selection

In practical purebred cattle breeding the progeny test has been extensively used Such famous breeders as Bakewell and Colling Brothers who lived in Great Britain used progeny testing very effectively in improving beef cattle In dairy cattle it is a fairly simple matter to test cows for yield, and progeny testing has been extensively used When testing the progeny of a bull to determine how much confidence can be placed in him as a future sire certain precautions should be taken to insure the accuracy of the rating given to him The following items should be taken into account (1) His daughters should be tested without selective bias, that is, all of his daughters should be tested, which is the best and most complete sample obtainable, or a specified number should be chosen in such a way that their choice has not influenced the level of their production (2) Enough daughters should be tested to insure a reliable average Five is the very minimum number, ten is a much more trustworthy sample (3) The plane of nutrition, care, and management given to the daughters compared to that accorded their dams, when dam-daughter comparisons are made, is important If the daughters have had a good environment and their dams subjected to a poor one, the sire will be overrated (4) The age at which the daughters are tested must be considered By most age correction tables well-developed two-year-old heifers are overrated In other words, at maturity their production is likely to be below that expected of them by the ratings given in the table Table 6 2, developed by W L Gaines, may be used to adjust yield made at any age to mature equivalent production Such corrections are necessary because age at time of test is a very important determinant in the production record of a cow

Various devices have been suggested to give a rating to the expected transmitting ability of a bull, that is, the production expected in the next group of daughters to be sired by him This is, of course, based upon what he has already accomplished in an earlier group of daughters The several mathematical expressions designed to be used in rating bulls are usually referred to as sire indexes or bull indexes

Sire indexes The sire index is a means of expressing a sire's transmitting ability from information gained by evaluating certain characteristics of his progeny In dairy cattle most indexes have dealt with milk and butterfat yields Several different concepts have

Table 6 2 Age Correction Factors for Annual Yield

To use this table first adjust the correction factor in the general table by taking into account the breed differences due to the relative time of maturity by adding or subtracting modified correction.

If Jersey, add 3 6 mo
If Guernsey, add 2 4 mo
If Ayrshire, subtract 3 6 mo
If Brown Swiss, subtract 6 0 mo
If Milking Shorthorn, subtract 6 0 mo
If the breed is Holstein Friesian use the table without modification

Example If a cow is 2 years and 5 4 months of age, the factors for the breeds would be Jersey, 1 27, Guernsey 1 29, Holstein, 1 33, Ayrshire, 1 40, Brown Swiss 1 46, and Shorthorn, 1 46

Age, y-m	Factor	Age y-m	Factor	Age, y m	Factor	Age, y m	Factor
1- 5 4	1 64	2- 0 4	1 43	3- 0 4	1 22	6- 5 2	1 01
1- 5 7	1 63	2- 0 8	1 42	3- 1 3	1 21	7- 3 5	1 00
1- 5 9	1 62	2- 1 3	1 41	3- 2 2	1 20	9- 7 9	1 01
1- 6 2	1 61	2- 1 7	1 40	3- 3 1	1 19	10- 8 3	1 02
1- 0 5	1 60	2- 2 2	1 39	3- 4 1	1 18	11- 4 5	1 03
1- 6 8	1 59	2- 2 7	1 38	3- 5 0	1 17	11-11 1	1 04
1- 7 1	1 58	2- 3 2	1 37	3- 6 0	1 16	12- 4 7	1 05
1- 7 4	1 57	2- 3 0	1 36	3- 7 2	1 15	12- 9 4	1 06
1- 7 8	1 56	2- 4 1	1 35	3- 8 5	1 14	13- 1 7	1 07
1- 8 1	1 55	2- 4 6	1 34	3- 9 7	1 13	13- 5 6	1 08
1- 8 4	1.54	2- 5 1	1.33	3-11 0	1 12	13- 9 0	1 09
1- 8 7	1.53	2- 5 7	1 32	4- 0 4	1 11	14- 0 3	1 10
1- 9 1	1 52	2- 6 2	1 31	4- 2 1	1 10	14- 3 2	1 11
1- 9 4	1 51	2- 6 9	1 30	4- 3.8	1 09	14- 6 0	1 12
1- 9 8	1.50	2- 7 5	1 29	4 5 6	1 08	14- 8 5	1 13
1-10 1	1 49	2- 8 2	1 28	4- 7 7	1 07	14-10 9	1 14
1-10 5	1 48	2- 8 8	1 27	4-10 1	1 06	15- 1 2	1 15
1-10 8	1 47	2- 9 5	1 26	5- 0 6	1 05	15- 3 3	1 16
1 11 2	1 46	2-10 2	1 25	5- 3 6	1 04	15- 5 4	1 17
1-11 6	1 45	2-10 9	1 24	5- 7 1	1 03	15- 7 3	1 18
1-11 9	1 44	2-11 6	1 23	5-11 4	1 02	15- 9 1	1 19
2- 0 4	1 43	3- 0 4	1 22	6- 5 2	1 01	15-10 8	1 20

been taken into account in formulating the mathematical equations designed to evaluate the transmitting ability of sires The majority of these can be included under one or the other of the following three basic concepts

The daughter average. One of the simplest equations for evaluating the competence of a sire is $S = \bar{o}$ In this equation, $S =$ the sire's transmitting ability, and $\bar{o} =$ the average production of his daughters

The main advantage of this index is that it can be used for any sire who has enough tested daughters to constitute a reliable average. Usually ten daughters are considered sufficient to justify the use of this method. More sires can be rated by this formula than by any other index.

One of the major weaknesses of this method of sire evaluation is that it disregards the influence of the dam. It has been demonstrated that the sire and dam contribute essentially equally to their progeny. Consequently, the true value of the contribution of the sire is overrated when the dams are better than the sire and underrated when the dams are inferior to him. If both are average the index is relatively reliable. Furthermore, no account is taken of the environmental influence upon the records.

The equal parent index. A less simple but genetically more descriptive index is based upon the concept that the sire and dam contribute equally to their offspring. A number of indexes that embody this concept have been proposed but the simplest expression of it is probably $S = 2\bar{o} - D$. In this equation, $S =$ the sire's transmitting ability recorded as milk yield, percentage of fat content, fat yield, or fat corrected milk, $\bar{o} =$ daughter's average production based upon the above values, and $D =$ the dam's record similarly considered.

The principal difference between this index and the straight daughter average is that the dam's production is taken into account and the sire is neither credited nor discredited with that portion of the inheritance influenced by the dam. For example, let us assume that the following situation exists: ten daughters of a sire average 12,840 lb of milk, and their ten dams average 9852 lb of milk. We can now substitute these values in the above formula and solve for S.

$$S = 2o - D$$
$$S = 2(12{,}840) - 9852 \text{ lb}$$
$$S = 25{,}680 - 9852 \text{ lb}$$
$$S = 15{,}828 \text{ lb milk}$$

It would then be assumed that this sire, under a similar environment, if mated with cows exactly his equal in transmitting ability would have daughters that would average 15,828 lb of milk.

The equal parent index can be applied to any measurable quality in cattle. It might be criticized because it does not separate influences due to inheritance from the effects of environment. If the environmental influence is essentially the same for both dams and daughters, then the index has its highest degree of validity. Further-

more this index becomes less reliable if dams and daughters differ widely in production and especially if either is well below or distinctly above the average production of the breed

The regression index. Regression might be broadly defined as the tendency any portion of a population has to resemble the whole population Stated in another way regression is a term used to indicate how much one variable is expected to change for each unit of change in some other variable A good example of the influence of daughter or dam regression is how much the milk yield of a daughter can be expected to increase for every 100 lb increase in the production of her dam The answer of course depends upon how much the dam s production is above or below the average of the breed The greater the difference the larger the influence or pull of regression The regression index was first developed by V A Rice[1] and was referred to by him as the *New Index* The mathematical equation used by Rice to compute this new or regression index is $S = W + (d - e)$ In this equation the symbols used are given the following meaning

S = Sire s transmitting ability
W = Breed average
d = Daughter's production
e = Dam s expected transmitting ability

In this index it is necessary to have a rather carefully calculated breed average For illustrative purposes let us assume that the Holstein breed has, in round numbers, an average milk yield of 12,000 with a percentage of fat content of 3 45 The daughters of the bull we are to evaluate average 14,850 lb of milk and their dams actually produced an average of 14 200 lb of milk The formula would be

$$S = W + (d - e)$$
$$S = 12\,000 + (d - e)$$
$$S = 12\,000 + (14\,850 - 13{,}100), \text{ or } (1750)$$
$$S = 13\,750 \text{ lb milk}$$

Choosing a proven sire A proven sire has been progeny tested sufficiently to provide evidence of his inheritance The Bureau of Dairy Industry[2] has indicated that a minimum standard for proof is five dam daughter pairs without any selection among the daughters The proof on a bull may be either favorable or unfavorable

[1] Rice V A A New Method for Indexing Dairy Bulls J of Dairy Sci., Vol. XXVII No 11 Nov., 1944
[2] U.S.D.A Misc Pub 6862 1949

Proven sires are usually five years or more of age when proof is obtained The advantage of using a bull with desirable proof is well understood, but the need to exercise good judgment in the procurement of such an animal is not so well recognized In the purchase of a proven sire it is important to take these items into account

1. Carefully evaluate the validity of the proof Bull proofs can mislead or deceive a purchaser Be especially skeptical if the records on the dams of the daughters are markedly below the average of the breed or herd, or if the daughters made extremely large first-calf productions

2 Be sure the bull is normally fertile

3 Check the bull for crampiness,[1] soundness, and general health Insist on freedom from tuberculosis, brucellosis, Trichomonas, etc

4 Learn what kind of a disposition he has and how well he handles, and then provide a safe pen and run for him See Chapter 13

5 If the bull is to be used in artificial service, be sure that semen can be readily collected from him

6 Estimate the future service that may be reasonably expected of him, and determine his value to you largely on that basis

In evaluating the breeding value of a proven sire consider the kind of daughters he produces Is their conformation such that they will last well in a herd? Do they have medium-sized desirable udders of good texture that will not be easily injured? If purebred cattle, do they have eye appeal? Are they rugged, with greedy appetites? These are all questions that should be affirmatively answered before a proven sire is put into heavy service, especially in an artificial breeding organization

Criteria for evaluating the transmitting ability of a young bull. When a calf is born it has all of the genetic ability it will ever possess Proof does not change the competence of an animal, it merely enables us to learn more about its inheritance There are never enough well-proven sires to supply the demand, therefore, it is extremely important to study carefully the qualities that are valuable in estimating the genetic ability of a young sire Be it ever remembered that the fewer the mistakes made in choosing young bulls, the higher the percentage of successfully proven sires we are likely to enjoy

The pedigree—its reliability in estimating inheritance. A pedigree is a record of the parentage or ancestry of an individual The basic

[1] Crampiness is most easily recognized by observing the animal when it first moves after it has been in a standing position If it suddenly raises its hind leg jerkily or extends it backward, the condition exists

portion of a pedigree records the name and number of each individual in the ancestry Such information is valuable insofar as it identifies the parents, but it is not particularly useful in determining the genetic qualities of an animal except when the parents are well known and their achievements widely recognized For the average pedigree to be useful in the selection of a young bull, information that bears directly upon the problem is highly desirable Breeders and pedigree companies recognizing the necessity of having much supplementary material displayed in the pedigree, frequently incorporate irrelevant information that does give the pedigree a good general appearance but is not of any particular use in determining the breeding value of the animal

Pedigree A is a good example of one that contains much useful information to guide a person in determining the ability of the ancestors of the animal to produce milk and butterfat, and to transmit that quality to their offspring Such information is very valuable in selecting a young bull, and the breeder who has available animals with ancestors displaying so much production on both sides of the pedigree has a high probability of success in choosing his next sire

Pedigree B is an excellent example of an attempt to confuse the inexperienced breeder and make him feel that he has a good deal of information regarding the individual Its information however is of little value because the animals and records mentioned are so distantly related to the bull in question that the probability of their influence on his germ plasm is relatively small Whenever a pedigree is submitted to you for observation be sure that the information relates directly to the animal in question and not to some relatively remote ancestor whose influence on the particular animal is of doubtful importance

Good ancestry an essential to good inheritance The dairy industry will profit by any methods which can be used to estimate the genetic value of young bulls more accurately Wide experience and careful study of the genetic principles involved indicate that certain qualifications in an animal are important and should be carefully and rigidly adhered to in the choice of a young bull Assuming that the sire and dam contribute equally to the genetic make up of the individual care must be exercised in evaluating both parents of the animal

The dam should have a production record made under environmental conditions somewhat similar to those of the herd in which the bull is to be used In fact, it is desirable for the dam to have

PEDIGREE A

Illini Homestead Piebe Prince 569148
In U of I herd
38 daughters with 110 records average age 3y 9m and mostly on 2×
Milk 13,353 0
Fat 531 0
Per cent fat 3 50
High daughter 365 da, 3×
Milk 21 840 0
Fat 921 0
Low daughter 365 da, 2× 2y
Milk 9191 0
Fat 322 1
Equal parent index age corrected to maturity basis
18 dam-daughter pairs
Milk 19 330 1
Fat 661.5

Prince Sylvius Ladoga 350430
In U of I herd
20 daughters with 52 records mostly 365 da and 3×
Ave milk 17,565
Fat 637 4
Per cent fat 3 69
12 of 20 daughters have records that average above 600 lb fat
High daughter 365 da 3× fat 828 4
Low daughter 365 da 2× fat 458 6 fat
In other herds 23 daughters 305–365 da
Ave 18 090 M 653 6 F.

Illini Homestead Piebe Bonheur 714496
A R O records
2y and 2m of age 365 da 3×
Milk 20 508 5 Fat 712 2
6y 4m 365 da 4×
Milk 28 855 6 Fat 1050 24
1 daughter Full sister to bull
3y 2m first calf
365 da 3×
Milk 21,759 1
Fat 735 1

Prince Colanthus Abbekerk 212547
45 tested daughters
Mostly for 7 and 30 days
Highest daughter, Lady Roverts Colantha
3½y Milk 29 290 0 Fat 1175 0
World's record when made
2 additional daughters at 3y 3m of age
Ave 621 2 fat

Ladoga Idaline Mercena 455693
Tested for 7 days only
4y Milk 630 5 Fat 22 70
5½y Milk 466 8 Fat 23 27
1 daughter tested
2 proven sons

Sir Bess Pieterje Piebe 201840
In U of I herd
4 daughters 5 records (all daughters)
Ave milk 19,789 Fat 689 3
High daughter milk 28 855 6 Fat 1050
Low daughter 2y milk 13 766 Fat 497 4

Illini Homestead Bonheur 533531
At 4y 2m 365 da 3×
Milk 10 584 4
Fat 748 7

Prince Abbekerk Mercena 133388
29 daughters tested mostly for 7 and 30 days
4 yearly tested daughters ave 365 da
Milk 24 927 Fat 894 3
Low daughter 584 lb fat

Pauline Colanthus Tensen 334241
365-day record
Milk 18 728 0 Fat 708 0
3 tested daughters, 2 for 7 days
1 yearly production 616 lb fat

Ruben Abbekerk Mercena 247038
10 tested daughters all for 7 or 30 days

Ladoga Idaline Veeman 104363
7-day record
Milk 528 Fat 20 36
3 daughters all better than their dam

Sir Pieterje Ormsby Mercedes 37th 110160
56 daughters with 64 records
Ave 20 106 M 657 9 F
Mostly 3× milking

Princess Mercedes Piebe 124232
2 yrs 365 da 3×
Milk 17,401 0 Fat 533 9

Emblagaard Tritomia Homestead 62924
27 daughters with 31 records
Ave 18 481 M 614 7 F
Mostly 3× milking
3 dau ave 855 7

Illini Johanna Bonheur 461196
1 A R O daughter

PEDIGREE B

Female

Melba Ormsby 393(?)(8)
By a son of Sir Moore Reka who has eight tested daughters, two with 20 lb production. He is from the 25-lb six-year-old Reka Ormsby and by Moore Mutual De Kol sire of 6 A R O daughters and 19 A R sons seventeen of the daughters having records above 20 lb.
Her sire is from a daughter of Sir Johanna De Kol Bessie, one of whose four tested daughters produced 26 53 lb butter at three years.
The dam is a granddaughter of Sir Johanna De Kol Bessie and of Sir Moore Reka, making a double cross of both these animals.

Oak Highland Johanna De Kol 67591
By a brother to the sires of
Moore Vee Pontiac 5y 38 64
Butter 7 days 4y 31 76
Lady Oak Fobes De Kol 38 14
Jessie Fobes Bessie Untested
Butter 7 days 4y 34 96
Butter 30 days 142 16
Butter 7 days 7½y 33 01
Butter 30 days 137 25
Butter 365 days 932 74
Lyndon Alcartra Polk 33 93
Butter 30 days 131 85
Butter 7 days 5½y 32 51
Butter 30 days 4½y 11 74
Bethje Moore 5y 32 55
Butter 15 days 87 18
Butter 7 days 6y 31 13
Butter 7 days 4y 31 13
Jessie Fobes Sunny De Kol
Butter 7 days 5y 30 51
Butter 30 days 6y 112 20
Butter 365 days 625 42

Sir Moore Reka 39435
8 A R O daughters
Ruffiga Jewel Orms 9½y 20 88
Milk 443 80
Dora Jewel Reka 6½y 20 03
Milk 507 50
Clo Ormsby Rijaneta 18 14
Milk 5½y 408 00
Hartwood Sylva Reka 3y 17 84
Milk 428 60
Valuma Mut De Kol 16 81
Milk 5y 360 30
One A R son

Moore Mutual De Kol 32846
36 A R O daughters
17 daughters over 20 lb
9 granddaughters over 30 lb
19 A R sons

Reka Ormsby 67591
Butter 7 days 6y 25 03
Milk 532 60
4 A R O daughters
One with over 20 lb
2 A R sons

Johanna Bell Aaggie De Kol 91811
Sister to
Joh Bessie D K 10y 22 25
Milk 438 20
Butter 305 days 8½y 631 62
Milk 17568 00
Butter 365 days 803 21
Milk 20103 30
Joh Jewel D K 7½y 20 03
Milk 381 80

Sir Johanna De Kol Bessie 33070
4 A R O daughters
Johanna Pauline Paul 20 55
Milk 3y 517 90
Butter (8 mo af calv) 10 40
2 others with over 20 lb

Belle Prairie Gross 41413
A daughter of Nicolas Aaggie Clothilde Jr and Valuma

Nora Ormsby Johanna 181695
Her sire by a brother to
Joh D K Van Beers 40 07
Butter 30 days 151 35
Butter 120 days 541 35
Her sire by a brother to the sires or dam of
Manor Johanna Piet Lady
Butter 7 days 5y 31 38
Manor Joh Korndyke Mond
Butter 7 days 8½y 33 76
Butter 30 days 139 74
Manor Joh Beets Lady
Butter 7 days 8y 30 98
Butter 30 days 124 20
Linden Johanna Rue 32 82

Prince Johanna Jewel Clothilde 40250
His sire by a brother to
Colin 4th s Johanna 35 22
Butter 30 days 138 51
Butter 365 days 1247 82
(world s rec when made)
His sire by a brother to the dam of
Johanna Darkness 8y 31 35
Butter 30 days 31 76

Sir Johanna De Kol Bessie 33070
4 A R O daughters
Joh Pauline Paul 26 53
Milk 3y 517 90
Butter (8 mo af calv) 10 40
2 others with over 20 lb

Aaggie Clothilde Jewel 54745
A daughter of Prince Aaggie Rijaneta Jewel and Maiden Aaggie Clothilde

Belle Ormsby Bakker De Kol 142303
By a brother to
De Kol Douglas 5th 4½y 28 39
Milk 591 20
Butter 30 days 113 64
Milk 2748 30
Snowball Pride Polk 28 21
Milk 5y 600 60

Sir Moore Reka 39435
8 A R O daughters
Ruffiga Jewel Orms 20 88
Milk 9½y 443 80
One other with over 20 lb
One A R son

Butter Bakker Belle De Kol 91956
A daughter of Gilbert Pauline Paul De Kol Rijaneta and Butler Mech

not only one record available, but also records of each year's production so that the cumulative or total lifetime yield of the individual is known. Bull calves whose mothers are consistent in production and calve regularly are better prospects than those whose mothers have one large record and failures in the majority of their lactations. The transmitting ability of the dam is also gauged to a large degree by the production of her daughters. It is highly desirable that the young bull have a sister, preferably a full sister, that has proven her value as a producer. If more than one sister is available, that, of course, is valuable additional information.

The sire of the calf should have at least six daughters that have been tested for production. These daughters should be unselected. Not only should his daughters show a high average level of production, but they should also be good individuals that show promise of a relatively long productive life. If this sire is from a cow that has made a good productive record and has produced daughters that have proven themselves, the probability of success is increased

In other words, in selecting a young bull, choose one whose ancestors have proven good for several generations and especially one whose dam and sire have both demonstrated *their ability* to transmit desirable dairy qualities. The bull calf whose pedigree is given in pedigree A had strong ancestry. He was placed into service with full confidence that he would prove out well when proof became available.

Five years later 18 dam-daughter pairs, including every daughter that had calved, showed by the application of the equal parent index that, if mated to cows exactly his equal in inheritance, this young bull could transmit 661.5 lb. butterfat. Figure 6.4 shows the bull and 12 of his daughters.

FIG. 6.4. The Holstein-Friesian bull, Illini Homestead Piebe Prince (pedigree A), and twelve of his daughters. This bull, selected as a calf because of the excellence of his ancestry, was proved in service to be as good a sire as his pedigree indicated he should be.

Sample the young sire carefully. No matter how promising a young bull may be, as judged by his pedigree and his ancestry, he should not be used too extensively until his own transmitting ability has been determined by sampling his daughters In order to do this properly it is desirable for him, if used in a single herd, to be mated to from twenty to thirty cows This should supply eight to fifteen daughters which, when tested for production, give a fairly representative and sufficiently dependable sample to indicate whether or not the bull should be continued in heavy service Not only should these daughters show productive capacity, but they should also be the right kind of cattle, the kind that should continue in production for a relatively long and useful life, possessing not only high yield but economical production as well

If a young bull is to be used in artificial service, he should be very carefully selected Blood line popularity is less important to his ultimate success in service than sound genetic competence Furthermore, he should be carefully sampled In artificial service more tested daughters are desirable than in single herd use Therefore, in order to have thirty to fifty daughters that will be tested to provide early proof on a bull, it is necessary to permit him to service 1000 or more cows The number of matings can be reduced if service is largely confined to herds that are regularly enrolled in D H I A or H I R production testing

A breeding program should be carefully planned You are now in possession of the fundamental or basic knowledge for breeding good cattle To do so in a minimum of time and without unnecessary mistakes, it is well to have a definite program, planned in advance A generation in cattle represents three to four years, and one can ill afford to make unwise selections of animals or to use methods that would cause the loss of a generation of progress

Choose a standard or level of production for your herd It is good practice in building a herd to set a minimum standard of production which cows must equal before they are permitted to remain in the herd In herds that are well established and properly managed, 350 pounds of fat is not too high a production to expect of the individual mature cow Here again, however, it is necessary to exercise judgment, occasionally high-class animals because of abortion or some other disease, may not reach that production Young animals, such as heifers milking with first calves, would be expected to produce less, probably 250 to 275 pounds of fat In taking a cow's record, it is advisable to consider the calendar year, from January 1 to

December 31, for instance, instead of the lactation period, since the calendar year includes the dry period when there is a feed cost but no production to be considered

Take into account within-herd variation When the herd is highly variable and not more than half of the animals average as high as the standard set, culling must be heavy At such times it is probably advisable to sell undesirable animals for beef and use the money so obtained to purchase superior individuals It is more desirable to purchase animals slightly below the average from a very uniform and good herd than to secure here and there a slightly superior animal from a highly variable herd, especially when the animal selected represents the best in the herd Such animals, when characters have a low heritability as milk production and type do, seldom breed as good as they are for those characters, whereas animals below the average in a very good herd often breed better than they appear to be

Follow the breeding system best adapted to your needs Unless your herd is quite outstanding it is unlikely that close inbreeding would be advantageous In general, line breeding is more likely to serve your purposes If new animals are introduced into your herd from other herds, they should be purchased with a definite purposo in mind In general, it is more desirable to introduce outside germ plasm through a sire In choosing animals, particularly a bull, do so with the idea of correcting the most glaring faults in your own herd Design your breeding program to correct faults but at the same time to bring about general improvement

Study the methods of well-established, successful breeders Breeders of this type have studied their problems thoroughly They have usually conferred extensively with their fellow breeders They are not easily disturbed or confused by popular fads or fancies, and they understand the problems that confront them A young breeder or dairyman is fortunate when be has such a breeder for a friend and adviser

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REVIEW

1 Is milk yield wholly a genetic problem? What does inheritance contribute?
2 How do we know that milk yield is inherited? How is it inherited?
3 *Explain additive gene action*
4 How can you change the characteristics of cattle by inheritance?
5 What are systems of breeding? What can you accomplish by their use?
6 What does inbreeding achieve? What problems may arise from inbreeding?
7 What is outbreeding? What is crossbreeding?
8 What is heterosis or hybrid vigor?
9 How do you upgrade a herd?
10 What is *a proven sire? How are sires proven?*
11 What is a sire index? Name three basic types of indexes
12 What points should be considered when buying a proven sire?
13 Does proving improve the genetic competence of a bull?
14 What characteristics about a pedigree are important to a buyer?
15 Why is a breeding program helpful? In what kind of a herd should culling be heavy?

7

Artificial Breeding

A new use is now being made of a very old art. This is possible because new techniques have been developed for collecting and processing semen, and a vast program of organization has been effected to make use of these new developments. As a result artificial insemination has enjoyed a phenomenal growth in dairy cattle reproduction. Furthermore, artificial breeding has a great potential for bringing about genetic improvement in cattle at a rate impossible when natural service only is practiced. The key to this improvement lies in the fact that fewer bulls are required, and therefore a more rigid selection of bulls is possible under this system.

Insemination by artificial means is not new. The knowledge that semen could be obtained from the males of a number of different species and manually introduced into the reproductive tract of females of that species, resulting in conceptions, has been known for several centuries. The first account in the literature of the use of artificial insemination is found in a statement widely publicized that in 1322 A.D. an Arab chieftain secretly obtained semen from a highly regarded stallion owned by a rival chieftain and successfully inseminated his own highly prized mare. Perhaps more trustworthy is the record that Spallanzani successfully reproduced dogs by artificial breeding in 1780. Although other records of successful reproduction by artificial insemination abound in the literature, it was not until the present century that serious study was given to the artificial breeding of domestic animals.

In 1899 the Russian physiologist Ivanoff began an intensive study of the artificial insemination of farm animals. In ten years he had developed a laboratory of artificial breeding and was the first to put the program into extensive use. The program in Russia was well suited to the collective farm system and as early as 1935 artificial breeding became an extensive enterprise in both sheep and cattle reproduction.

About this time Danish farmers became interested in the artificial breeding of their cattle and by 1936 they had artificial insemination

cooperatives well established It was probably from the Danish experiences that the incentive to introduce artificial breeding into the program for the genetic improvement of cattle in the United States was developed For it was Professor E J Perry of the New Jersey Extension Service, after a visit to Denmark who was first inspired to develop an association for the purpose of breeding dairy cattle by artificial service In May 1938 a cooperative artificial breeding association was formed in New Jersey by 102 dairymen who contracted to artificially inseminate 1050 of their cows By 1939 seven units had been organized in the United States and 7539 dairy cows were enrolled

Artificial breeding has had a rapid development in the United States. In 1952 reports compiled by the United States Department of Agriculture state that approximately one-fifth, or 20 per cent, of all of the cows kept for milk production calve each year as a result of an artificial service Table 7 1, again taken from U S D A reports, indicates the growth of artificial breeding from 1939 (when it began) to 1953

It is unlikely that any other program designed for cattle improvement has had the same acceptance, or developed with the same

Table 7 1 Growth of Artificial Breeding in the United States, 1939–1953

Year	Organizations (Units), no	Herds, no	Cows Bred, no	Total Sires Used, no
1939	7	646	7,539 *	33
1940	30	2,971	33,977 *	138
1941	42	5,997	70,751 *	237
1942	73	12,118	112,788 *	412
1943	99	23,448	182,524 *	574
1944	95	28,627	218,070 *	657
1945	195	43,998	360,732 *	729
1946	336	73,293	537,376	900
1947	608	140,571	1,184,168	1,453
1948	963	224,493	1,713,581	1,745
1949	1,263	316,177	2,091,175	1,940
1950	1,460	372,968	2,619,555	2,104
1951	1,653	467,224	3,509,573	2,187
1952	1,618	543,397	4,295,243	2,324
1953	1,623	571,921		2,598

* Prior to 1946, cows were reported only on the basis of enrollment.

degree of general support, as has the artificial breeding of dairy cattle There are good reasons for this rapid development

Advantages attributed to artificial breeding. There are a number of advantages that have a direct personal appeal to the individual dairyman For example, dairymen have no desire to keep a bull about the premises, especially an old bull with a belligerent nature Such bulls are dangerous and create a hazard that all dairymen would like to avoid Furthermore, in most areas, the bulls used in artificial breeding are better and the cost of service, especially in small herds, is less than with natural service Such advantages are real and they are important, but the most significant advantages deal with the potential for the genetic improvement of cattle

Artificial breeding accelerates (speeds up) genetic improvement. Improved techniques in collecting, processing, storing, and shipping semen have enabled *artificial breeding units and federations* to inseminate a large number of cows with a single ejaculate of a bull This together with other factors has increased the average number of cows serviced in a single year by one sire from 228 in 1939 to 1848 in 1952 This greater opportunity enables a single sire to have as many daughters in 1952 as eight sires did when artificial breeding was introduced in 1939 Figure 7 1 shows the extent to which cows inseminated per sire have increased since the program began

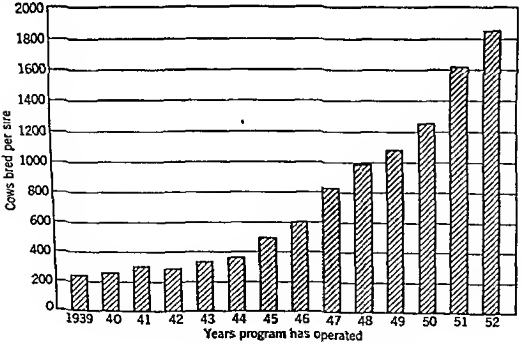

FIG 7 1 Cows bred per sire 1939–1952

It requires approximately 60 per cent of the females born to maintain a constant number of milking cows in a herd. The percentage varies from year to year but over a period of years six out of ten heifers are required for replacements. Even with a vigorous culling of females, including the elimination of all of the heifers not needed for replacements, genetic improvement by this method is relatively slow. Bulls however, used in artificial insemination occupy quite a different position in a selection program. Whereas six out of ten females must be used for breeding purposes one in a hundred or one in two hundred bulls would be adequate. By making greater use of the better germ plasm as artificial breeding has done more rapid genetic improvement has resulted. This is the most important contribution of artificial insemination.

Distance is no longer a barrier in mating animals. There was great difficulty and considerable expense when it was necessary to transport one animal to the other to complete a mating. With the minuteness of the package conveying semen and by means of modern methods of transportation it is easily possible to inseminate a cow with semen that has been transported many thousands of miles. The distance barrier in mating dairy animals has been bridged by artificial insemination.

Artificial breeding is a boon to the small breeder. It is the dairy cattle breeder with only a few milking cows who profits most from artificial insemination. By this system he has access to better sires than he could afford to buy. Furthermore he rids himself of the menace incurred by keeping a bull and at the same time reduces the actual cost of service. If he keeps or contemplates keeping registered cattle he can do so with the assurance that he can have access to better germ plasm by artificial service than that possessed by his own cows. Thus he can improve his own herd without buying new blood.

The possession of better germ plasm resulting in cattle with greater production capacity, usually stimulates or induces better management practices an important item in improving the efficiency of the dairy enterprise.

Artificial insemination is making dairymen more sire conscious. Vastly more genetic improvement is made by the wise choice and extensive use of sires than through any method of selection that can be made in cows. This fact is more generally recognized and accepted since artificial breeding has had widespread use. Sires which

have been extensively used in artificial breeding have produced as many as 10,000 daughters Very few cows will produce more than five daughters If the assumption is made that the cow and the bull transmit equally of their desirable or undesirable qualities, then the numerical advantage in favor of the bull is overwhelming

We must not, however, lose sight of the value of the cow in the genetic make-up of the bull Essentially one-half of his transmittible qualities are inherited from his dam The germ plasm of the cow is therefore most productive when transmitted to a highly qualified son

Artificial breeding focuses attention on outstanding cow families Artificial breeding organizations are constantly in search of better germ plasm In the long pull their contribution to cattle improvement will depend upon how successful they are in locating genetic competence At first, when artificial breeding was new, this search was limited to bulls that had proven out well in private herds Bull-selection committees of the various associations bought these bulls and put them into artificial service That source of supply, although highly desirable, has been largely exhausted Currently, replacements for bulls that have been in service must in many cases be produced and then proven

This need for superior germ plasm has resulted in a search for strong breeding cow families Such cows have demonstrated their transmitting ability through their daughters and in some cases, also, through their sons The locating of cow families that reproduce well should be made more intensive, and when such cows are located they should be mated to the best bulls available Their bull calves should then be sampled to determine their breeding ability, and if worthy they should be placed in extensive artificial service

Some less important advantages of artificial insemination (1) Often valuable breeding animals that because of injury or for other reasons cannot be used in natural service can be used artificially (2) Old and heavy bulls can be mated to heifers without injury to them (3) Breeding and calving records are more likely to be kept, because they are a part of the program, than if bulls run with the herd (4) Certain communicable diseases can be more easily controlled with artificial insemination (5) Less harm is done to a single herd if a bull with poor inheritance is used

Disadvantages that artificial breeding has not yet fully overcome In any program that is new, weaknesses sooner or later develop

Many of these can in time be overcome Artificial breeding has hod its share of such problems

Members cannot make individual matings In most artificial breeding organizations the program has not developed to o point that a breeder can choose the sire from which semen is obtained for the insemination of a particular cow in his herd Seldom can he hove many daughters sired by the some bull His only choice of semen is that offered by the inseminator when the cow is served This is a disadvantage particulorly to the breeder of purebred cattle

Heat periods in certain cows are sometimes difficult to identify The success of the artificial insemination program depends upon the early identification by the dairyman of oll cows that are in oestrus (or heat) Many cows especially when confined in a stanchion barn show very little external evidence of oestrus In such cows it is very easy to overlook a heat period and therefore the calving interval[1] may be extended beyond the twelve month period usually desired

Late breeding may reduce the conception rate Cows remain in heat varying lengths of time The limits usually fall between 4 and 30 hours with the mean approximately 18 hours It is important for the dairyman to recognize oestrus in a cow or heifer in its eorlier stages He can then if artificial breeding is used advise the technician so that the animal can be inseminated during the later stages of oestrus or very soon after it has terminated Table 7 2 indicates the importance of introducing semen into the reproductive organs of the cow at the proper time

If breeding has been delayed because heat was not detected in time to enable the insemination of the cow at the proper stage of oestrus then the probability of obtaining a conception at that service is markedly reduced This is a very important aspect of artificial breeding Dairymen should therefore observe their herds at least two times each day to detect cows in heat Especially is it important early in the morning to identify cows that came into heat during the night and promptly communicate that information to the inseminator

It requires a considerable concentration of cows to employ an inseminator If a technician is to obtain a satisfactory income he must inseminate from 1200 to 1500 cows each year Since he must

[1] Calving interval is the time which lapses between one calving and the next subsequent calving At average levels of production cows appear to do best when they calve every 12 months

Table 7 2 Breeding Results from One Service to Females Bred Experimentally by Artificial Insemination at Various Intervals before and after Ovulation *

Time of Service	Females Bred, no	Conceived, no	Conception, %
One to several days before oestrus	14 †	0	0 00
Over 24 hours before ovulation but in oestrus	15	8	53 33
19–24 hours before ovulation	15	11	73 33
13–18 hours before ovulation	14	12	85 71
7–12 hours before ovulation	14	11	78 57
6 hours or less before ovulation	14	8	57 14
2 hours or less after ovulation	20	6	30 00 ‡
6 hours after ovulation	20	8	40 00 ‡
12 hours after ovulation	20	5	25 00 ‡

* Trimberger, George W 1948 U of Nebr Research Bul 153

† These 14 females were not included in the general comparisons made on oestrus and ovulation since they were bred at an abnormal time

‡ Highly significant statistical differences

travel by car to each farm, his territory should be confined within a radius of 20 miles Small dairy herds located in areas that are sparsely populated with dairy cattle are obliged to keep their own bulls or make special arrangements to have their cows artificially bred, usually by their local veterinarian

Organizations that provide artificial breeding service It was reported by Hirsch and Hedges[1] that cooperatively owned organizations provided 90 per cent of all of the semen used in artificial breeding during the year 1948 Privately owned organizations are, however, becoming more actively interested in providing artificial service A few very well known privately owned or company owned and operated artificial breeding organizations inseminate cows in many states and operate on the national level

Cooperative organizations are usually designed to operate in one of the following ways (1) The cooperative owns bulls which are kept at a central location Semen is collected, processed, and taken by inseminators from this collection point directly to the field Such units are usually small and operate on limited capital (2) Artificial breeding federations have a central establishment where a large number of bulls are kept Semen is collected, processed, and in this case shipped daily to local units where it is dispensed to local inseminators who take it to the field In this type of organization the

[1] Hirsch D E and Hedges I R 1949 USDA Farm Credit Cir 133

inseminators are employed by and report to their local unit or operate independently (3) Centralized cooperative organizations own bulls usually a very large number of them representing all of the breeds of dairy cattle, and collect, process, and ship the semen to county or other similar unit organizations These units, including the inseminators, may either be responsible to the central organization (employed and discharged by it) or the local units may have their own identity, with the inseminators responsible to the county or local group organization

Some misconceptions regarding artificially bred animals. Some persons have gained the impression that an artificially produced animal is superior simply because it has been produced by an artificial service There is no difference between progeny produced by artificial and natural service if the parents are the same Artificial breeding in dairy cattle is simply a method for procuring, processing, and introducing semen into the reproductive tract of a cow It does not change the genetic qualities of the germ plasm or semen If artificially bred animals are superior it is only because the germ plasm of the semen was superior, not because of the method of reproduction

Transplantation of the fertilized bovine ovum. At several experiment stations in the United States and in a number of foreign countries, research is in progress on the transplantation of the bovine embryo In 1951 Willett, Block, Casida, Stone, and Buckner [1] reported that they had successfully produced a calf by transferring a fertilized egg from one cow to another cow The host in this case carried the transplanted embryo of the donor to full term and successfully produced a living calf Again in 1953 [2] Willett et al reported that they had been able to successfully produce three additional calves by this process In all of the cases reported by Willett and his co-workers, the animal from which the fertilized eggs were obtained was sacrificed

These experiments, therefore, mark a step in the progress of embryo transplantation They have demonstrated that it is now possible to

[1] Willett, E L Block, W G, Casida L E, Stone, W H and Buckner, P J Successful Transplantation of a Fertilized Bovine Ovum 1951 Science, *113* 247

[2] Willett, E L, Buckner P J, and Larson, G L Three Successful Transplantations of Fertilized Bovine Eggs 1953 J Dairy Sci., Vol XXXVI, No 5 pp 520–523

transplant a fertilized ovum from the reproductive tract of one animal to the reproductive tract of another and that the recipient or host can carry this transplanted embryo for the full gestation period, give birth to the resulting calf, and therefore complete the reproductive cycle

The great hurdles yet to be gone over if transplantation becomes an effective procedure for cattle improvement are (1) for the donor (presumably an animal of superior genetic qualities) to produce large numbers of ova that have been duly fertilized and that can be recovered for transplantation without sacrificing her own life, and (2) that the recipient whose reproductive cycle is synchronized with that of the donor be capable of producing at an economic level during the period she is carrying the transplanted embryo Of these two problems the former is the more difficult

It is possible by using the hormone F S H, a product of the pituitary gland, to obtain multiple ovulation in the cow But procedures to flush these fertilized ova from the reproductive tract of the real (genetic) mother have not yet been successfully worked out without sacrificing the life of the mother The present stage of research does not, therefore, fully answer the practical and economic aspects of the problem This process is still in the experimental stages It is not available for cattle improvement as is artificial insemination

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REVIEW

1 What is artificial insemination? Why has it developed rapidly in dairy cattle breeding?

2 Name several advantages attained by artificial insemination

3 How can artificial breeding speed up genetic improvement?

4 What size of breeder benefits most from the artificial breeding service? Why?

5 What are cow families? Why are they important in breeding cattle?

6 What are the disadvantages of using artificial insemination?

7 What type of organization provides most of the artificial insemination service?

8 What is transplantation of the fertilized bovine ovum?

9 What problems are still unsolved concerning the use of the transplantation technique?

10 At what point in the oestrus cycle of the cow is an artificial service most likely to be effective?

8

Feeding the Dairy Cow during the Winter Season

The milk yields and cash returns from the dairy enterprise are often low because the owner or operator does not have a keen appreciation of the possibilities for improvement One of the simplest means of improving the returns from the dairy herd is through better feeding of the cows during the winter Doing a good job of feeding milk cows is a comparatively simple operation once the underlying principles are understood The discussion which follows presents in a simple manner those principles and guides which will enable any intelligent person to feed dairy cows satisfactorily Most of these principles apply to summer feeding as well as to feeding during the winter

Providing a ration with good qualities A satisfactory ration for dairy cows must be made up of feeds which will supply as many of the following qualities, or characteristics, as possible (See the section 'Feeding Terms" at end of chapter)

Palatable High milk yields can only be obtained when there is high feed consumption Hence all feeds should be so palatable that dairy cows eat large amounts of feed day after day throughout the year Provide appetizing qualities in the ration (1) by using hays and silage which are free from mold and mustiness and have a high green color, (2) by feeding roughages which are not unusually coarse, and (3) by using grain mixtures which are made up of wholesome feeds, that is free from mold, mustiness, rodent droppings, and other foreign substances

Succulent Cows consume larger quantities of feeds (fresh weight basis) and consume them more rapidly when the feeds are fed in moist condition than when they are given in dry form For winter feeding silage is the most commonly used succulent feed in the northern dairy sections, in some of the southern states, however, there is a growing tendency toward the use of specially planned pastures which provide some grazing throughout most of the winter (Chapter 21)

A high moisture content of the feed does not in itself ensure high nutritive quality and does not mean that the feed is more nutritious than if it were fed in dry form The Vermont Experiment Station (Bul 412) found that cows fed rations which included silage or moistened beet pulp produced no more milk than did comparable groups of cows fed the same kinds of feeds after they had been dried

Adequate in nutrients Supplying inadequate amounts of nutrients limits or lowers yields On farms where large amounts of low protein feeds such as corn corn silage corn stover oats barley and grass hays are fed milk yields are often limited because of too small an amount of protein being fed Cows capable of high production may not reach high levels of yield because of insufficient amounts of total digestible nutrients Some guide to the nutrient requirements of dairy cows is therefore necessary Such a guide is explained later in this chapter

Highly digestible Sixty five to 90 per cent of the dry matter of cereal grains and grain by products is digestible but only 50 to 70 per cent of dry matter of high grade roughages is digestible Grinding low quality feeds such as weeds and badly weathered coarse hays does not enhance their nutritive value although grinding sometimes increases the consumption of such forages To ensure adequate nutrient intake feed coarse roughages judiciously and in addition supply sufficient amounts of well formulated grain mixture

Not too bulky Good rations for dairy cows should always contain as much roughage as possible because roughage is usually the most economical source of nutrients and is also the main source of the dairy cow s mineral and vitamin supply In the early part of the pasture season cows frequently consume so much watery pasture grass that they do not care for grain and do not obtain sufficient nutrients from the grass to support their production Under such conditions the hours at pasture may be limited so that they will eat some grain mixture

Slightly laxative The best rations for milk production are those which have a slightly laxative effect Feeds which produce this effect are green pastures silage legume hays wheat bran and molasses

Wholesome Moldy musty or blackened feeds or newly made hay and silage often cause cows to go off feed or cause serious illness Feeds containing sandburs poisonous weeds rodent droppings or other foreign materials should be avoided

Conducive to good milk flavor Silage, turnips, cabbage, rape, wild onions, sweet clover and rye pastures, ragweeds and other strong-smelling weeds may cause bad flavors in milk if cows have access to them within 6 to 8 hours before milking Sudden changes in the kinds of feeds fed or quickly changing from barn feeding to pasture may cause indigestion, diarrhea, and poor milk flavor

Good-flavored milk requires the use of well-cured roughages, concentrates that are in good condition, and pastures that are free from objectionable weeds

Varied Once a supply of appetizing feeds suitable for milk production has been obtained, there is usually no need to change the kinds of feeds being fed from day to day or week to week as long as the feeds remain in excellent condition

Because of the function of the microorganisms of the rumen in breaking down feed proteins and in building new proteins, the protein needs of the dairy cow may be supplied from only one or two feeds Urea, a simple factory-produced nitrogenous material, may be used to supply a part of the protein [1]

Economical The cost of feed usually makes up about half (40 to 60 per cent) of the cost of milk production Savings made in the selection of low-cost feeds which will make up a good ration often have a profound effect upon the profit from the enterprise

The market prices of feeds change frequently, giving an opportunity for the exercise of good business judgment in the selection of economical feeds Total digestible nutrients are usually obtained most cheaply in unmarketable roughage, such as pasture forage, the lower grades of hay, corn stover, and sorghum stover There is not a wide difference in the cost of total digestible nutrients in purchased roughage and concentrates, the cost of nutrients in purchased hay sometimes exceeding that in concentrates The high-protein feeds, such as cottonseed meal, usually furnish digestible protein at a lower cost per pound than do feeds low in protein, such as sorghum grain, corn, and oats

[1] One hundred pounds of a commercial form of urea known as Two Sixty-Two equals 262 pounds of protein when added to low protein rations for dairy cows When one pound of this product is mixed with 7 pounds of farm grains the mixture replaces 7 pounds of high protein feed such as soybean meal However urea contains no feed nutrients in it elf other than protein equivalent while the usual protein supplements supply mineral and other nutrient values Because of possible toxic effects when fed in large quantities Two-Sixty-Two should be used to the extent of not more than 3 per cent of the grain mixture

Selecting suitable roughages. High-quality legume hay and well-preserved silage are the preferred roughages for the winter feeding of milk cows. Usually more roughage is consumed when it is of high quality than when it is poor. Feeding high-quality roughage, therefore, not only lessens the amount of grain mixture needed, but, if the roughage is legume hay or silage, it also lessens the amount of protein supplement needed in the grain mixture.

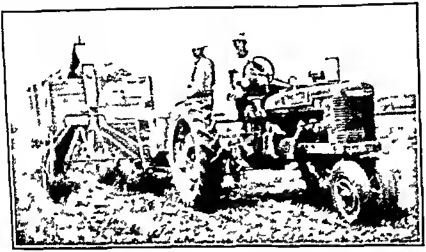


FIG. 81. High-quality legume hay is the best foundation upon which to build an economical winter ration for milk production. In the United States hay is the chief roughage consumed by dairy cows during the winter.

Feeding roughage freely. The roughage portion of the ration (1) provides most of the vitamins, (2) supplies a large part of the minerals, and (3) furnishes the raw materials from which the microorganisms of the rumen and other parts of the digestive tract manufacture the vitamins of the B group, as well as many compounds which are essential to the normal functioning of the body and the synthesis of milk by the udder. Hence, it is good feeding practice to supply dairy cows with all the good-quality roughage they will consume without undue waste, and then, if needed, supply a suitable grain mixture in addition.

It is usually desirable that silage feeding be restricted so that cows eat hay freely in addition to silage. Even when grass or legume silage is fed, it is best that some dry hay be consumed in addition. Discard moldy or decayed portions of the silage before feeding.

Feed roughages other than hay and silage judiciously. Such feeds as corn stover, kafir, and sorghum cane can be utilized to advantage if it is understood that they cannot take the place of legume hay

Corn stover and sorghum forage are low in protein, and only a small part of the amount fed is eaten Hence, legume hay or legume silage should be fed in addition

Preparing an appropriate grain mixture. The feeding of roughage only without concentrates may be the most economical method of feeding for milk production Such a situation sometimes is found in the western states and occasionally in other areas where there is an abundance of high-quality legume roughage and where concentrates are high in price in relation to the returns from the milk Under most conditions, however, the feeding of concentrates to cows capable of high production is a profitable procedure, provided an appropriate grain mixture is used and provided further that the grain mixture is fed with due regard to the needs of the cows

Select economical grains and supplements In most sections of the country, commercially mixed feeds may be purchased ready for feeding Some service companies deliver the feeds to the farm either in sacks or in bulk If in bulk form, they can be handled through conveyors and bins without the necessity of sacking them Where such feeds or services are available, study the costs of the ready-mixed feeds in comparison with the cost of a home-mixed batch of feed made from home-grown grains and purchased supplements It will usually be found that the ready-mixed feed is somewhat more expensive than the home-mixed, but the extra cost may be justified if the labor saved can be otherwise employed in productive work On farms where herds are small or where grinding and mixing equipment is lacking, the purchase of ready-mixed feeds may be the preferred method The home-mixed method usually brings savings in (1) the cost of sacks, (2) freight, and (3) mixing cost

Study the method of determining cost of nutrients in feeds as given in a later section, and select economical feeds for your needs

Determine the percentage of protein needed Successful preparation of the grain mixture depends in large measure upon the ability of the operator to judge the quality of his roughage and then to make up a grain mixture which will properly supplement that particular kind and quality of roughage Use the following guides in determining the percentage of protein needed in the grain mixture

1 When the cows are on excellent, green, growing pasture which furnishes an abundance of feed, a simple mixture of farm grains having a total protein content of about 10 per cent may be used

2 When the roughage consists of legume hay or legume silage only (that is, when no corn silage, corn stover, or pasture is fed),

the grain mixture should contain from 12 to 14 per cent total protein

3 When the roughage consists of legume hay, together with corn silage or stover, or when mixed hay alone is fed, the grain mixture should contain from 14 1 to 16 per cent total protein.

4 When the roughage is all non-legume such as timothy, redtop, millet Sudan grass, corn silage and stover the grain mixture should contain from 16 1 to 18 per cent total protein

FIG 82 These twin silos one slightly larger in diameter than the other store a bountiful supply of silage for both winter and summer feeding Silage and stover form about one tenth of the rations of dairy cows

5 When the roughage is of excellent quality, a grain mixture that contains the lower percentage of protein given in each of rules 2, 3, and 4 is used If the roughage is weathered has few leaves, or contains a large proportion of weeds, the higher figure should be used

6 When the roughage is definitely of high quality and is fed in unusually large amounts, the grain mixture may safely contain slightly less protein than specified in these rules

Example Suppose that medium-quality alfalfa hay and medium-quality corn silage, together with ear corn and oats, are on hand With this partly legume and partly non-legume roughage, a grain mixture containing 14 1 to 16 per cent total protein is needed, and since the roughage is of medium quality, about 15 per cent total protein will be right

In planning the grain mixture to supply the needed amount of protein it is usually best to keep in mind the kinds and amounts of home-grown feed on hand and to calculate a mixture that will, so far as possible, use the feeds in these proportions. Thus if the amount of oats on hand is only two-thirds the amount of corn (in pounds), a mixture might be made up to contain 3 parts of corn to 2 parts of oats.

Calculate costs of nutrients. Obtain prices of feeds at your local feed store and consult Table 8.1 for the amount of digestible protein

*Table 8.1 Nutrients in 100 Lb. of Common Feeds, lb.**

Feed	Dry Matter	Total Protein	Fiber	Calcium	Phosphorus	Digestible Protein	Total Digestible Nutrients
Concentrates							
Barley	90	13	6	0.07	0.32	10	70
Beet pulp, dried	91	9	20	0.68	0.06	4	72
Brewers' dried grains							
18–23% protein	92	21	18	0.10	0.47	10	67
23–28% protein	92	25	16	0.16	0.47	21	72
Buckwheat	87	10	9			7	65
Corn, shelled	87	9	2	0.01	0.20	7	77
Corn-and-cob meal	89	8	9			6	71
Corn gluten feed	90	28	8	0.11	0.78	23	78
Corn gluten meal	92	43	4	0.10	0.47	38	78
Corn-oil meal	91	22	11	0.06	0.62	17	81
Cottonseed meal							
33–38% protein	93	37	13	0.28	1.30	30	65
38–43% protein	93	41	12	0.19	1.11	34	68
Over 43% protein	93	44	11	0.18	1.15	30	69
Distillers' dried grains	93	28	15	0.04	0.29	20	82
Hominy feed	90	11	6	0.03	0.44	8	88
Kafir grain	88	11	2	0.01	0.25	8	77
Linseed meal							
33–38% protein	91	35	8	0.36	0.84	31	74
38–43% protein	91	40	8	0.33	0.74	35	75
Molasses, cane	76	3		0.35	0.06	1	60
Oats, grain	92	12	11	0.10	0.40	9	74
Peanut meal							
38–43% protein	94	42	10	0.10	0.50	37	79
43–48% protein	93	45	14	0.17	0.55	40	79
Over 48% protein	93	51	9			46	78
Rye, grain	90	11	2	0.04	0.37	9	80
Sorgo, grain	87	9	3			5	69
Soybeans, seed	92	39	5	0.22	0.67	35	93
Soybean meal							
38–43% protein	92	42	6	0.29	0.67	38	77
43–48% protein	92	45	6	0.34	0.71	40	76
Velvet beans	90	26	0			19	74
Wheat	88	12	2	0.05	0.38	9	74
Wheat bran	91	10	10	0.10	1.14	13	61
Wheat standard middlings	90	17	5	0.09	0.90	13	63

* Adapted from Yearbook, U.S.D.A.

*Table 8 1 Nutrients in 100 Lb of Common Feeds lb * (Continued)*

Feed	Dry Matter	Total Protein	Fiber	Calcium	Phosphorus	Digestible Protein	Total Digestible Nutrients
Animal Products							
Blood meal	86	78	1	0.35	0.24	66	
Bone meal steamed	97	11	2	27.00	15.00		
Buttermilk dried	94	34	0	1.32	0.95		
Fish meal	93	62	1	4.31	2.68	52	
Milk skim	9	3	0	0.13	0.10	3	8
Milk skim, dried	95	36	0	1.34	0.99		
Milk whole	13	3.5	0	0.12	0.09	3.4	14
Whey	6	1	0	0.04	0.04		
Whey dried	93	13	0	0.73	0.60		
Dried Forages							
Alfalfa hay	93	15	30	1.[illegible]1	0.21	12	54
Alfalfa leaf meal	91	21	16	1.42	0.25		
Alsike clover hay	89	14	2[illegible]	0.[illegible]8	0.20	10	53
Barley hay	85	7	21	0.17	0.25	4	60
Bermuda grass hay	91	7	25	0.60	0.16	4	44
Bluegrass hay	88	9	28	0.30	0.21	6	60
Birdsfoot trefoil hay	91	14	28	1.15	0.22	10	51
Bromegrass hay	86	9	27			6	48
Corncobs	89	2	30			0	45
Corn fodder	88	7	23			3	54
Corn stover	89	6	30	0.45	0.10	2	51
Cowpea hay	90	18	21	1.84	0.25	12	48
Kafir fodder	91	7	28	0.31	0.0[illegible]	3	53
Ladino clover hay	88	19	21	1.32	0.29	14	55
Lespedeza hay	92	12	29	0.80	0.25		
Millet hay	93	9	29			6	55
Oat hay	88	6	27	0.27	0.22	3	48
Oat straw	92	4	30	0.23	0.20	1	42
Prairie hay	90	4	30	0.55	0.07	1	[illegible]0
Red clover hay	93	16	24	1.01	0.14	10	[illegible]0
Redtop hay	91	8	29	0.35	0.18	5	54
Sorgo fodder	88	5	26	0.27	0.15	2	5[illegible]
Soybean hay	92	16	24	1.26	0.22	11	[illegible]3
Soybean straw	91	6	3[illegible]			1	35
Sudan grass hay	95	10	28	0.47	0.24	4	51
Sweet clover hay	92	16	26	0.74	0.08	12	52
Timothy hay	93	8	30	0.31	0.13	3	[illegible]3
Silage and Roots							
Alfalfa silage	31	6	9			4	16
Beet pulp dried	91	9	26	0.66	0.06	4	72
Carrots	11	1	1			1	10
Corn silage	39	2	7			1	17
Mangel-wurzel	9	1	1	0.02	0.02	1	7
Peavine silage	25	3	8			2	14
Red clover silage	28	4	8			2	12
Sorgo silage	2[illegible]	2	7	0.09	0.04	1	16
Soybean silage	24	2	10	0.29	0.10	2	13
Sugar beets	22	2	3	0.0[illegible]	0.06	1	21

* Adapted from Yearbook, U.S.D.A.

and total digestible nutrients in these feeds Compute the costs of 100 pounds of these nutrients according to the method below

> Price of cottonseed meal, 43% protein, \$3 00 per cwt
> Digestible protein in 100 lb , 36 lb
> \$3 00/36 × 100 = \$8 33, the cost of 100 lb digestible protein in cottonseed meal
>
> Price of corn gluten feed, 28% protein, \$2 50
> Digestible protein in 100 lb 23 lb
> \$2 50/23 × 100 = \$10 87, the cost of 100 lb digestible protein in corn gluten feed

Cottonseed meal at \$3 00 per 100 pounds is thus a cheaper source of protein than corn gluten feed at \$2 50 per 100 pounds In the same manner, compute the cost of 100 pounds of total digestible nutrients (TDN)

> Price of shelled corn per bu (56 lb) \$1 68
> TDN in 100 lb of corn, 77 lb
> \$1 68/56 × 100 = \$3 00 the value of 100 lb shelled corn
> \$3 00/77 × 100 = \$3 89, the cost of 100 lb TDN in corn
>
> Price of wheat per bu (60 lb), \$1 92
> TDN in 100 lb wheat 74 lb
> \$1 92/60 × 100 = \$3 20 the value of 100 lb wheat
> \$3 20/74 × 100 = \$4 32 the cost of 100 lb TDN in wheat

The calculation shows that shelled corn at \$1 68 per bushel is a less expensive source of TDN than wheat at \$1 92 per bushel Since farm grains are best fed in ground form, the cost of grinding should be added to the cost per 100 pounds of feed whenever the costs of TDN in whole farm grains are being compared with the costs of feeds already ground

Calculate a formula Corn and oats will not make a mixture containing 15 per cent total protein, for shelled corn contains only 9 per cent total protein and oats only 12 per cent (Table 8 1) Therefore a feed with a higher percentage of protein must be added to the corn and oats Suppose cottonseed meal and wheat bran are added to the mixture in the proportions shown below Then 103 5/762 × 100 = 13 6, the percentage of total protein in the mixture In order to raise the percentage of protein to about 15 per cent, more cottonseed meal should be added When the amount of cottonseed meal is increased to 100 pounds, the mixture then weighs 812 pounds and contains 124 pounds of total protein 124/812 × 100 = 15 3, the percentage of total protein This mixture meets the requirements

Feed	Amount of Feed, lb	Total Protein: In 100 Lb of Feed lb	Total Protein: In Amount of Feed Used in Mixture, lb
Ground shelled corn	300	9	27
Ground oats	200	12	24
Wheat bran	200	16	32
Cottonseed meal	50	41	20 5
Salt	12	0	0
	762		103 5

satisfactorily, as a supplement to the medium quality, part-legume roughage

Determine cost of mixture The cost of the mixture per batch and per ton may readily be computed if the costs of the feeds per bushel or ton are known Assume the prices are shelled corn, $1 40 per bu , oats, $0 80 per bu wheat bran, $64 per ton, cottonseed meal, $80 per ton, trace mineralized salt, $30 per ton, grinding and mixing, 20 cents per cwt

Shelled corn $1 40 − 56 (lb per bu) × 300	$ 7 50
Oats $0 80 — 32 (lb per bu.) × 200	5 00
Wheat bran $64 — 2000 (lb per ton) × 200	6 40
Cottonseed meal $80 — 2000 (lb per ton) × 100	4 00
Salt $30 — 2000 (lb per ton) × 12	0 18
Grinding and mixing 812 lb feed @ 20¢ per cwt	1 62
Total cost for 812 lb mixture	$24 70

$24 70/812 × 2000 = $60.84 the cost per ton

Using other methods of calculating mixtures A number of other methods of calculating grain mixture formulas are in use One of the simplest is described below

Box method of figuring grain mixtures A short cut method of figuring the amounts of feeds needed to make up a grain mixture having a specified percentage of protein is known as the box, or square method

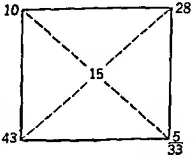
Problem The feeds on hand are shelled corn, oats, and 43% cottonseed meal How much of each feed is needed to make a mixture containing 15 per cent total protein? At current prices corn is cheaper than oats as a source of TDN

1 Calculate the average protein content of a mixture of 2 parts corn and 1 part oats

200 lb	corn at 9% protein (Table 8 1)	= 18 lb	protein
100 lb	oats at 12% protein (Table 8 1)	= 12 lb	protein
300		30	

30/300 × 100 = 10% protein in corn-oats mixture

2 Draw a box with diagonal dotted lines Place the figure for desired protein percentage in center and percentages of protein in feeds at the left corners Subtract along diagonal lines (disregarding + or − signs), and place differences at right-hand corners Add the differences



3 The results of the calculation show that 5 pounds of cottonseed meal containing 43% protein, added to 28 pounds of a combination of 2 parts corn and 1 part oats will make a grain mixture having exactly 15% protein

4 To compute the amount of each feed needed to make 1 ton of grain mixture, proceed as follows

5/33 × 2000 =	303 lb	cottonseed meal
28/33 × 2000 =	1697 lb	corn-oats mixture
	2000	

Of the corn oats combination, two thirds (1131 3 lb) will be corn, and one third (565 7 lb) will be oats

5 To prove the results

303 lb	cottonseed meal at 43% protein	= 130 3 lb	protein
1697 lb	corn-oats combination at 10% protein	= 169 7 lb	protein
		300 0	

300/2000 × 100 = 15% protein in mixture

If desired three or more farm grains may be used instead of only two or two or more protein supplements may be combined in the same manner as shown above for corn and oats If this is done, first find the average protein value for the combination chosen and place this value at the side of the box

Feeding grain mixture as needed A number of facts should be considered in deciding whether or not grain mixtures should be fed and in determining the amounts per feeding

1 High producing cows ordinarily cannot eat enough roughage to support high milk yields Concentrates furnish more nutrients per pound and occupy less space than do roughages so that a higher nutrient intake may be obtained when grain mixtures are fed than when the ration consists of only roughage

2 Will it pay to feed grain mixture? A broad general rule for feeding grain mixtures is 1 lb of grain mixture to each 2½ to 3 5 lb of milk produced by Guernseys and Jerseys, 1 lb of grain mixture to

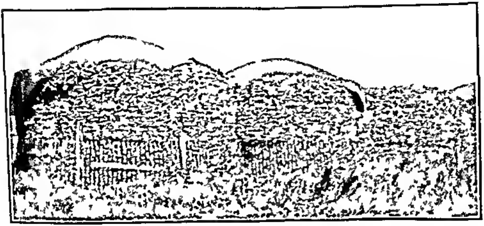


FIG 83 Farm grains comprise about one-sixth of the rations for dairy cows The corn in these large cribs standing at the edge of a Nebraska corn field helped to feed dairy cows in grain-deficient areas

each 3 to 4 lb of milk produced by Ayrshires, Brown Swiss, and Holsteins In the example given above, it was found that the home-formulated grain mixture cost $60 84 a ton or approximately 3 cents a pound Will the feeding of 3 cents worth of grain mixture bring an increase in milk yield worth 3 cents or more? If no larger yields are obtained when grain mixture is fed than when only roughage is given, obviously it will not be profitable to feed grain Under normal conditions, a pound of milk sells for nearly as much or more than a pound of grain mixture If the feeding of 1 pound of grain mixture brings a production of 3 pounds of milk (average under good conditions), then 1 pound of milk pays for the grain and 2 pounds of milk may roughly be considered as returns above feed cost

3 The labor and facilities needed for feeding the grain mixture must be considered in determining whether or not it is profitable to feed grain The use of pen type, or loose stabling, complicates the task of feeding cows individually (Chapter 27)

4 Under most conditions, cows with high yields make greater returns above feed costs than do those with low yields (Chapter 19)

Recommended rates for the feeding of grain mixture to dairy cows during the season when they are completely barn fed are given in Table 8 2 Use these rules as guides for average conditions Some

Table 8 2 *A Guide to Winter Feeding of Grain Mixtures (Cows Completely Barn Fed)*

Kind of Roughage	Breed of Cattle	Amounts of Grain Mixture to Feed Daily: Roughage Fed Liberally (all that the cow will eat without undue waste)	Roughage Fed in Moderate Amounts
All legume	Ayrshire, Holstein, Swiss	1 lb grain mixture to 3 5 lb milk	1 lb grain mixture to 3 lb milk
All-legume	Guernsey, Jersey	1 lb grain mixture to 3 lb milk	1 lb grain mixture to 2 5 lb milk
Part or all nonlegume	Ayrshire, Holstein, Swiss	1 lb grain mixture to 4 lb milk	1 lb grain mixture to 3 5 lb milk
Part or all nonlegume	Guernsey, Jersey	1 lb grain mixture to 3 5 lb milk	1 lb grain mixture to 3 lb milk

cows are much better consumers of roughage than are others Cows eating large amounts of roughage may not need as much grain as prescribed in these rules For the most economical results, study each cow's needs by gradually raising and lowering the amounts fed until the best point is reached As lactation advances, adjustment in the amounts fed must be made for declining yields Also as already mentioned, the live weight of the cow must be watched Sometimes it is desirable to feed grain mixture during the dry period to maintain or increase body weights (Chapter 11)

It cannot be emphasized too strongly that weighing or measuring the grain mixture for each cow at each feeding time is one of the most important of all operations in connection with the management of a dairy herd This, of course, requires the keeping of records of yield, as explained in Chapter 12

Providing ample quantity of minerals The mineral needs of dairy cattle can be supplied in a simple and effective manner

Common salt Permit dairy cows each day to have free access to salt Supplying salt only once a week to high-producing cows is not satisfactory The crystal form of salt is usually preferable to block

salt for winter feeding Include salt in the grain mixture at the rate of 1.5 to 2 pounds in 100 pounds of grain mixture Salt blocks attached to the stanchion may be used even though the grain mixture contains salt Salt blocks are also useful in pastures

Phosphorus Dairy cattle fed entirely on forage grown on phosphorus low soils may suffer from serious disturbances, including slow rate of growth, lessened milk production impaired reproduction, and breakdowns in health Phosphorus is best supplied through the use

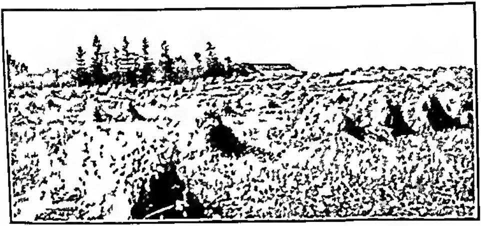


Fig 8.4 Oats comprise a valuable component of grain mixtures for dairy cows The crop also provides straw for bedding and serves as a companion crop for meadow and pasture seedings

of well balanced concentrate mixtures containing feeds especially rich in phosphorus such as cottonseed meal wheat bran linseed meal, soybean meal, and gluten feed When only small amounts of these protein supplements are being consumed and when grass pastures on low phosphorus soils supply the forage, a phosphorus supplement such as steamed bone meal or defluorinated rock phosphate may be needed The legume forages are not, as commonly assumed, rich sources of phosphorus so that substituting legume for nonlegume hays or pasture does not solve the problem of phosphorus deficiency The application of phosphorus fertilizers to low phosphorus soils usually enhances the phosphorus content of the forages grown thereon The use of complete fertilizers on impoverished soils may increase not only the yield but also the phosphorus and protein contents of forages

Calcium The need of dairy cows for calcium is fully as great as the need for phosphorus, chiefly because of the large amounts of these elements in milk

The principal source of calcium for milk cows is the legume forages (pasture, hay, or silage) The legume forages are much richer sources of this element than are the non-legume forages Rations lacking legume forage or having only small amounts of legume forage may be supplemented by keeping a mixture of 2 parts ground limestone, 2 parts steamed bone meal, and 1 part salt in a container to which the cattle have free access If this arrangement is not feasible, as in winter, incorporate these substances in the grain mixture at the rate of 1 pound limestone, 1 pound bone meal, and 1 5 to 2 pounds salt in every 100 pounds of grain mixture

Trace minerals A number of mineral elements are required by dairy cattle in such small quantities, or traces, that they are commonly referred to as trace minerals Among these is *iodine,* a deficiency of which may cause the death of calves before birth or goiter or "big-neck" after birth In areas around the Great Lakes and in the Northwest, particularly Montana, cases were found in which the iodine content of soils and water was so low that beneficial effects were obtained by feeding an iodine supplement In a number of states deficiencies of other trace elements, notably cobalt, copper, iron, and manganese, have been reported These instances usually occurred where livestock was fed forages grown on soils naturally low in fertility or on soils which had become impoverished through long-continued cropping and erosion Simple expedients for protection against such deficiencies in regions where there is reason to believe that a deficiency may exist are using a "trace-mineralized salt" in place of ordinary salt, and fertilizing the soil with a complete fertilizer which contains small amounts of the trace elements found to be deficient

Toxic minerals Some mineral elements are not readily excreted from the animal body and become cumulative poisons Among these elements are *fluorine, lead, molybdenum,* and *selenium* Rock phosphate (a calcium-phosphate compound) should not be used as a mineral supplement for dairy cattle unless its fluorine content is naturally low or has been reduced (defluorinated) to a safe level Both calves and older cattle appear to crave *lead* paints Eating small amounts of such paints may cause serious illness or death *Selenium* is found in forages and grains grown on certain alkali soils in the Great Plains area and molybdenum occurs in forages in a few areas Although the quantity present is extremely small on a percentage basis, the continued intake of such feeds leads to a fatal illness The chief remedy for this trouble is prevention, that is, avoiding the use of the affected feeds

Ensuring an adequate vitamin intake. Dairy cows receiving well-planned rations containing ample amounts of high-quality roughage including good pasture and well-preserved green hay and silage, seldom need vitamin supplements even though vitamins are required for body health, milk production, and reproduction The explanation for this amazing situation is a simple one First, many of the vitamins of the B group (including such vitamins as niacin, thiamine, riboflavin, pantothenic acid, and vitamin B_{12}) are either present in ample amounts in the feed or are synthesized by the cow during the processes of rumen fermentation and digestion and assimilation from the intestine Secondly, the vitamins which ordinarily must be given greatest attention in dairy cattle feeding, namely, vitamins A and D, are usually present in ample quantities in high-quality sun-cured roughage In case good rations are not fed, however, care must be exercised to avoid vitamin deficiencies

Vitamin A Green roughages have a high content of carotene, a yellow pigment which is masked by the green chlorophyll The yellow carotene is readily seen in such vegetables as yellow carrots

Table 8 3 Estimated Carotene Content of Feeds in Relation to Appearance and Methods of Conservation *

Feedstuff	Carotene mg /lb
Fresh green legumes and grasses, immature	15 to 40
Dehydrated alfalfa meal, fresh, dehydrated without field curing, very bright green color	110 to 135
Dehydrated alfalfa meal after considerable time in storage, bright green color	50 to 70
Alfalfa leaf meal, bright green color	60 to 80
Legume hays, including alfalfa, very quickly cured with minimum sun exposure, bright green color leafy	35 to 40
Legume hays, including alfalfa, good green color, leafy	18 to 27
Legume hays, including alfalfa, partly bleached, moderate amount of green color	9 to 14
Legume hays, including alfalfa badly bleached or discolored, traces of green color	4 to 8
Non-legume hays including timothy, cereal, and prairie hays, well cured, good green color	9 to 14
Non-legume hays, average quality, bleached, some green color	4 to 8
Legume silage	5 to 20
Corn and sorghum silages, medium to good green color	2 to 10
Grains, mill feeds, protein concentrates, and byproduct concentrates, except yellow corn and its byproducts	0 01 to 0 2

* National Research Council Recommended Nutrient Allowances for Dairy Cattle 1950

and yellow mangels. The animal converts a part of the carotene of feeds into vitamin A, a colorless substance. Some of the carotene in unchanged form appears in body fat, skin secretions, and in the butterfat.

Symptoms of vitamin A deficiency are "shy breeding," severe malnutrition, night blindness, and the birth of weak or dead calves.

Dairy cows are best fed throughout the year on ample quantities of high-quality, green roughage. Alternate procedures for preventing vitamin A deficiencies are (1) to feed alfalfa meal having a high

FIG. 8.5. Soybeans grown for seed supply large quantities of soybean meal, a high-protein concentrate used extensively in rations for dairy cattle feeding.

carotene content at the rate of about 2 pounds daily per cow; and (2) the use of a commercial vitamin A concentrate.

Vitamin D. This vitamin is required by growing cattle. It aids in the assimilation of calcium and phosphorus and in the prevention of rickets. The needs of mature cattle for vitamin D are less clearly defined. In the case of dairy cows, deficiencies are seldom noted but have been observed under long-continued experimental feeding of rations extremely low in vitamin D content.

Sunlight brings about a chemical change in certain compounds in plants after the leaves or other portions have become partly dried, converting the compounds to vitamin D. Sun-cured hay is one of the best sources of this vitamin for cattle, although silage made from crops which have become partially dry usually contain some vitamin D. The liberal feeding of sun-cured roughages and the pasturing of cattle are two of the best ways of ensuring an adequate vitamin D intake. A third method of supplying vitamin D to dairy cows, should this be necessary, is to include in the grain mixture a commercial vitamin A and D supplement.

Vitamin E and ascorbic acid. The use of these vitamins has been reported to have had beneficial effects in cases of delayed conception in dairy cows and impaired fertility in dairy bulls, but carefully conducted research has failed to reveal the necessity for the use of these substances as a routine procedure for the prevention or correction of breeding troubles. Vitamin E is widely distributed in feeds, and ascorbic acid is synthesized within the body.

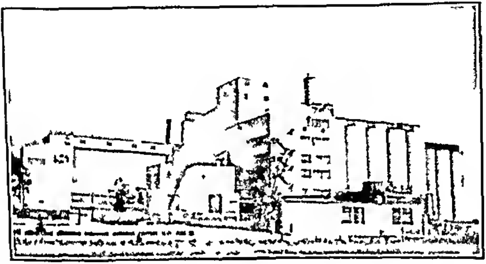


Fig. 86. This soybean mill has capacity for extracting the oil from several million bushels of soybeans annually. A bushel of beans yields about 10 pounds of oil and 48 pounds of meal.

Studying feeding terms. A brief explanation of some of the more common terms used in the discussion of feeding dairy cattle is given below.

Feed is the term applied to the roughages, grains, mill feeds, and pasture crops consumed by livestock.

Roughage is coarse feed, such as pasture forage, hay, and silage.

Succulent feeds are high in water content, such as fresh growing grass and silage.

Concentrates are feeds, such as shelled corn and cottonseed meal, which have a high nutrient content per 100 pounds.

Cereal grains are the seeds of corn, oats, wheat, sorghum, and other similar crops.

A *grain mixture* for dairy cattle is usually made up of one or more farm grains with sufficient protein feed added to bring the protein

content to a desired level Salt and other mineral supplements may be included

Nutrients are the chemical compounds or groups of compounds, such as protein and minerals, which nourish animals

A *ration* is the feed set aside for or consumed by a farm animal in a one-day period

A *balanced ration* is a ration which meets exactly the nutrient needs of an animal without excess or deficiency

A *maintenance ration* furnishes the proper amounts of nutrients to keep a mature animal in good health and condition without change in live weight when it is doing no work or producing no product

A feed *supplement* is a feed which supplies nutrients in which the ration is deficient For example, cottonseed meal is termed a protein supplement because it is so high in protein content that when included in a dairy grain mixture it increases the percentage of protein in the mixture The term supplement should not be confused with "substitute"

A *feeding standard* is a statement of the amounts of nutrients required by a farm animal

Total digestible nutrients is a term used to describe the total feeding value of a feed The term is frequently abbreviated to TDN For discussion and method of calculation, see Chapter 10

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REVIEW

1 List ten qualities of a good ration for a dairy cow and discuss each

2 Point out the *factors to be kept in mind when selecting and feeding* roughages

3 List the rules governing the percentages of protein needed in grain mixtures.

4 Explain and illustrate a method for calculating the cost of (*a*) protein (*b*) TDN in feeds.

5 Explain and illustrate the box method of figuring grain mixtures

6 How is grain mixture best apportioned to the individual cow? Outline rules for feeding grain mixtures to cows of each of the dairy breeds.

7 Discuss the (*a*) mineral needs (*b*) vitamin needs of dairy cattle and outline practical methods of supplying adequate quantities of each of the mineral elements and vitamins needed

8 List and define the feeding terms commonly used in connection with the preparation of rations for dairy cows

9

Feeding the Dairy Cow during the Pasture Season

Good pastures are usually the most economical sources of feed for dairy cattle Not only do good pastures furnish large amounts of protein and total digestible nutrients at low cost as compared with winter feeding, but cattle at pasture benefit greatly from the abundance of vitamins and other health-promoting factors in fresh green forage Moderate exercise and some exposure to the sun while cattle are at pasture are also beneficial

The length of the pasture season is closely related to climate In Florida, Southern California, and other areas which have warm climates, pasture feeding may be employed during a large portion of the year One of the most promising methods of pasture improvement in the southern and central sections of the United States is the development of pasture systems which provide grazing for 10 or more months of the year In some regions, protection of dairy cows from hot sun is more of a problem than protection from cold temperatures In the northern states and in Canada, pastures afford good grazing for only four to five months of the year Then, too, in cold climates dairy cows must be adequately protected from extremely low temperatures

Learning the characteristics of pastures. Many dairy farmers assume that when cows are turned to pasture in spring much responsibility as well as labor has been removed, and that from then on for a period of several months the cows can care for themselves so far as obtaining a supply of feed is concerned This is often a serious mistake, for even though pasture forage is abundant, it may be so high in water content that the cows cannot consume enough of it to supply their needs Later in the season, milk yields may decline at an unusually rapid rate even though the pasture forage appears to be ample in quantity, or the pasture may fail completely as a source of feed Why do pastures not remain as constant a source of nutrients as do hay and silage fed during the winter?

Grass pasture variable in yield and composition An understanding of the natural growth habits and nutrient composition of grasses is essential to correct feeding of dairy cows which graze grass pasture Whenever the pasture fails to supply sufficient nutrients, supplementary feeds must be offered in order to maintain milk yields at their normal levels

In early stages of growth, that is, when they are only 2 to 4 inches in height, most pasture grasses are high in water content, often having not more than 10 to 12 per cent of dry substance Under these conditions, a large amount of forage must be consumed if cows are to obtain most of their digestible nutrient supply from it Usually this is not possible in the case of high-producing cows It is estimated that a dairy cow can consume from 100 to 150 pounds of forage a day when the pasture furnishes excellent grazing Assuming the grass has a dry-matter content of 10 to 12 per cent, her intake is only 10 to 18 pounds of dry substance daily Under barn-feeding conditions, a cow weighing 1200 pounds and producing 30 pounds of 4 per cent milk would be fed at least 18 to 20 pounds of dry hay or equivalent, and in additioa, 10 to 12 pounds of grain mixture

On the other hand, young grass is a good source of protein At early stages, pasture grasses such as bluegrass, timothy, redtop, orchard grass, and bromegrass have a protein content equal to that in alfalfa and the clovers Considered on the dry-matter basis, the protein level in these grasses at early stages is equal to or higher than that in well-cured legume hay The high proteia intake of cows during the early part of the pasture season is undoubtedly one of the factors responsible for the greatly increased volume of milk produced at this time

Most pasture crops make their greatest growth during the early part of the growing season In pasture experiments conducted at the University of Illinois, Urbana, samples taken in the pastures monthly formed the basis for the calculation of yields It was found that two-thirds of the yields of bluegrass and bromegrass were produced before July 15 Alfalfa pasture produced approximately 60 per cent of its total yield during the same period On the other hand, Sudan-soybean pasture, during a six-year trial, gave only 14 per cent of its yield prior to July 15 Normally the growth of the grasses becomes much slower as maturity is approached and may come to a standstill unless weather conditions are especially favorable for the production of new leaves and stems In the northern states, the

grasses normally reach the seed stage in late May or in June and after that time produce new leaves but no new seed stalks.

High soil temperatures bring about early maturity and also cause cessation of growth of many species of grass unless rainfall is plentiful Throughout the New England, north Atlantic, and north central states grass pastures are usually brown and nearly bare of herbage during midsummer With cooler weather and late summer or autumn rains, the grasses revive and again furnish good grazing, although yields are not as large as in spring

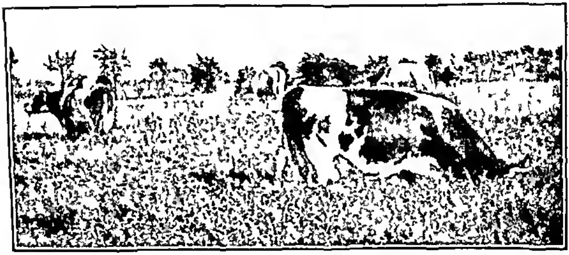


FIG 91 *The need for supplementary feed is reduced to a low point when dairy cows graze high-yielding grass legume pastures*

Legume pastures continue growth A number of legume crops are more dependable and satisfactory than the grasses for grazing purposes because of their tendency to continue growth even under adverse weather conditions Alfalfa is outstanding in this respect In many dairy sections alfalfa forms the mainstay as the only or principal crop in pastures from mid-July until cooler weather arrives The first cutting of alfalfa is usually harvested for hay or silage Some of the clovers, also, are more persistent in growth than are the grasses Ladino clover, first-year sweet clover, and red clover usually continue their growth after grasses have become ripe

The legumes, however, are not without fault as pasture crops A number of the best pasture legumes are subject to winter-killing and to certain infectious diseases such as bacterial wilt Because of their appetizing qualities, some legumes are grazed more greedily than the grasses, thus weakening the legumes and lessening their stand Often the legumes which are seeded in grass-legume pasture mixtures

are reduced to a negligible proportion of the mixture after two to four seasons of grazing Reseeding legumes is usually more expensive than reseeding grasses One of the greatest deterrents to the use of legumes, particularly alfalfa and Ladino clover, is the danger of bloat In the southeastern states and in the Midwest, Ladino clover helps greatly to improve yields of pastures, but its wider use is limited by reports of losses of cattle being pastured on it California farmers are said to have had much trouble with bloat in cattle while grazing alfalfa, but the difficulty is by no means confined to one state Although surveys show that less than 1 per cent of cattle grazing legume pastures were attacked by bloat (U S D A , BDI-Inf 138) the loss in individual herds may be severe The bloat problem is discussed further in Chapter 16

Grass-legume mixtures preferred Grass pastures have a number of outstanding advantages, including (1) their tendency to form a dense turf which is resistant to tramping, (2) their highly nutritious and appetizing qualities during the early part of the pasture season, (3) their ability to spread and fill up bare spots, (4) the safety with which they may be grazed (fewer cases of bloat occur on grass pastures than on legume pastures), (5) their ability to withstand close grazing and other mismanagement practices, and (6) their ability to survive over a period of many years The advantages just given, of course, apply only to long lived pasture grasses and do not include short-lived or annual crops such as Sudan grass, annual rye grass, and millet

Grass pastures have such great limitations, as set forth in an earlier section, that they are uneconomical as the only pasture crops for high-yielding dairy cows The legumes also have disadvantages, but fortunately a suitable combination of a grass and a legume or a mixture of grasses and legumes often overcomes most of the disadvantages of both classes of crops For example, a *bromegrass-alfalfa* mixture, which has become popular in the midwestern states as a pasture crop, has many of the good qualities and overcomes most of the common faults of both grasses and legumes In the Southeast, mixtures of Ladino clover and tall fescue or Ladino clover and some other grass adapted to the area have proved far more valuable for pasture than grasses alone or legumes alone

The introduction of legumes into grass pastures is effective in bringing about (1) a higher yield of forage, (2) an increase in the protein content of the grass itself and of the mixture as compared

with only grass, (3) a greater yield of protein to the acre, (4) an increase in the calcium content of the mixed forage, (5) a better distribution of yields of forage during the grazing season, (6) an improvement in the appetizing qualities of the herbage, (7) a beneficial effect on the nitrogen content and texture of the soil, (8) improved residual effects on the soil for the benefit of succeeding crops, and (9) a higher level of milk production with yields sustained more evenly throughout the season. The U. S. Department of Agriculture reports (BDI-Inf. 138) that orchard grass grown alone contained 12.3 per cent protein (dry basis) while the same kind of grass when grown with Ladino clover had a protein content of 14.3 per cent. Corresponding figures for tall fescue were 12.0 per cent and 15.8 per cent, respectively. The influence of Ladino clover on the yields of forage and yields of protein were also striking (Table 9.1).

Table 9.1. *Influence of Ladino Clover on Yield and Protein Content of Pasture Herbage* *

Crop	Dry Matter Yield, lb.	Protein Content, %	Protein Yield, lb.
Orchard grass alone	2392	12.3	231
Ladino clover alone	3852	27.0	1026
Orchard grass and Ladino clover when grown together	7981	16.5	1174
Orchard grass when grown with Ladino clover	6575	14.3	815
Ladino clover when grown with orchard grass	1406	27.0	359
Tall fescue alone	2944	12.0	303
Ladino clover alone	3852	27.0	1026
Tall fescue and Ladino clover when grown together	7671	19.5	1374
Tall fescue when grown with Ladino clover	5263	15.8	762
Ladino clover when grown with tall fescue	2408	27.4	612

* Hodgson, R. E. Importance of Legumes in Dairy Pastures. BDI-Inf. 138. (U.S.D.A.)

Supplying supplementary feed. Too often dairy cows are expected to obtain from pasture all the nutrients they require. Pasture forage is comparable to the roughage portion of the ration. It was pointed out in the discussion of winter feeding of the dairy cow (Chapter 8) that high-producing cows cannot obtain sufficient amounts of nutrients from roughage alone. Further, pastures usually decline in productivity during midsummer and furnish amounts of feed far less

than the roughage portion of the winter ration As a rule, therefore, high producing cows need additional feed when being pastured There is opportunity for the exercise of good judgment in the selection of a suitable and an economical supplement for the purpose

Early spring Because of the rapidly changing conditions in the pasture as already explained and the possibility of using one or more of a number of different supplements be sure to choose the supplement best suited to your conditions A number of these possibilities are discussed in the following sections

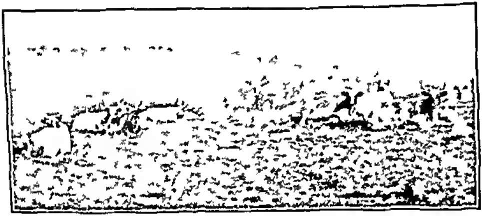


FIG 32 When pastures consist of only grasses and are located on soils of low productivity constant attention must be given to supplying high yielding cows with the proper kinds and amounts of nutrients

Since early spring pastures usually supply an abundance of roughage and the cows prefer it to any other feed the most suitable supplement for early spring pasture conditions is a feed which will furnish much nutrient material in concentrated form Further early spring pasture herbage whether legume or non legume, is relatively high in protein (on a dry matter basis) It is obvious, therefore, that the feed which best meets these requirements is a grain mixture of low protein content

Grain mixture makes an excellent supplement to pasture since (1) it can be adjusted almost exactly to the needs of each cow assuming of course that the pasture continues to supply an adequate amount of roughage (2) the protein content of the mixture may be adjusted from time to time as occasion demands in order to compensate for the changing conditions in the protein content of the pasture herbage, (3) the feeding of the grain mixture at milking time is an inducement in getting the cows to the milking quarters at the proper time, and

(4) in some areas, particularly the grain-growing sections of the country, it is often the most economical supplement.

Suggested rates of feeding grain mixture as supplement to pasture are given in Table 9.2. Sometimes pastures in early spring are so

Table 9.2. Kind and Amounts of Grain Mixture to Be Fed to Cows at Pasture

Condition of Pasture and Protein Content of Grain Mixture	Breed of Cattle and Amounts of Grain Mixture to Feed Daily			
Excellent, green growing pasture about 10% total protein content	Ayrshire, Holstein, Swiss	1 lb grain mixture to each 3 lb milk over 25 lb	Guernsey, Jersey	1 lb grain mixture to each 2.5 lb milk over 16 lb.
Good grass pastures not yet at ripening stage and legume pastures in summer about 13% total protein content	Ayrshire, Holstein, Swiss	1 lb grain mixture to each 3 lb milk over 20 lb	Guernsey, Jersey	1 lb grain mixture to each 2 5 lb, milk over 14 lb
Grasses beginning to ripen and grass-legume pastures with grasses nearly ripe· about 15% total protein content	Ayrshire, Holstein, Swiss	1 lb grain mixture to each 3 lb. milk over 15 lb.	Guernsey, Jersey	1 lb grain mixture to each 2 5 lb. milk over 12 lb
Fully ripened grass pastures· about 17% total protein content	Ayrshire Holstein, Swiss	1 lb grain mixture to each 3 lb milk over 12 lb	Guernsey, Jersey	1 lb. grain mixture to each 2 5 lb milk over 10 lb.

appetizing it is difficult to induce cows to eat all of the grain mixture they need to sustain the yields of which they are capable. If insufficient grain mixture is eaten, the cows may lose weight rapidly and milk yields are sure to fall at a faster than normal rate. Cows on good pasture differ greatly in the readiness with which they consume grain mixture. Some cows eat little if any grain unless special care is used to provide for this situation. If cows require grain mixture and eat too little of it because of luxuriant forage in the pasture, remove the cows from pasture a few hours before feeding time.

As a rule, no pasture supplement other than a grain mixture is required in spring. Occasionally pastures become short early in the season, and when this occurs one of the methods of supplementing pastures in midsummer may be employed.

Midsummer. As pointed out, midsummer pastures are likely to have two faults, namely, low yield and low protein content, although the presence of a high proportion of legumes in the forage tends to keep the protein content higher than that found in all-grass pastures. With grass pastures especially, there is usually need for supplying

additional feed with considerable amounts of both protein and total digestible nutrients

Plans for furnishing extra feed in midsummer include the use of (1) dry roughage, such as good-quality legume hay, (2) grain mixture (3) emergency pasture crops, (4) silage, (5) soiling crops, and (6) a combination of any two or more of these Choose the plan which best meets your needs, keeping in mind especially the labor requirements of each plan

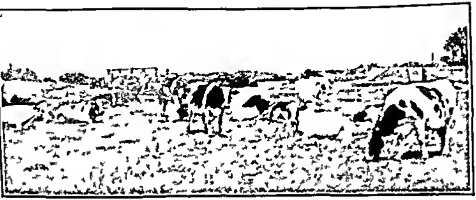


Fig 93 Supplying roughage such as hay silage or freshly harvested green forage in racks in the pasture is a good means of supplementing scanty pastures Frequent moving of the rack is advantageous in distributing the excreta of the cows

Good-quality legume hay, such as alfalfa, may replace half of the grain mixture customarily fed to dairy cows at pasture In experiments at the University of Illinois, one group of cows consumed 10 1 pounds of grain mixture daily while a comparable group ate 5 4 pounds of grain mixture plus 11 3 pounds of alfalfa hay The average daily yield per cow for the first group was 33 7 pounds FCM [1] and of the second group 32 2 pounds The two groups of cows grazed the same pasture and the amount of pasture herbage consumed was not determined Presumably the cows which were fed hay consumed less pasture forage This plan of supplementing pasture appears to be well suited to conditions in which the amount of available pasture is small.

When supplementing midsummer pastures which consist of legumes or which contain a considerable proportion of grasses not yet at the mature stage, have enough protein feed in the grain mixture to bring

[1] For an explanation of this term, see Chapter 12

its total protein content to 12 to 14 per cent. When the grasses begin to ripen and grass-legume pastures contain grasses which are nearly ripe, raise the protein content of the grain mixture up to about 15 per cent (range, 14 to 16 per cent). For fully ripened grass pastures, use a grain mixture containing about 17 per cent. Feed these mixtures at the rates suggested in Table 9.2.

Emergency pasture crops, consisting of annual or other pastures which supply an abundance of grazing in midsummer when grass or grass-legume pastures are short, form one of the most economical ways of meeting the midsummer feed shortage. The cows harvest the forage, thus saving much labor as compared with the use of plans which call for the feeding of grain mixtures or roughages in barn or dry lot. Fresh-growing pasture also has the further advantage of supplying the factors so essential to good health, as discussed in Chapter 8. For these reasons, milk yields are likely to continue at higher levels than when only grain mixture is used as a supplement to failing or dried-up pasture.

When planning an emergency or temporary pasture for midsummer grazing, choose one which is best adapted to your conditions. For both the northern and southern states, one of the improved varieties of Sudan grass, such as sweet Sudan, may be sown alone or as a mixture with soybeans. This crop is usually ready for grazing in 6 to 8 weeks after planting. In pasturing Sudan grass, care must be taken to avoid the danger of prussic acid poisoning. The crop should not be grazed until it has reached a height of at least 18 inches and cattle should be kept off the pasture during a severe drouth and after frosts. The crop grows so rapidly and furnishes such an abundance of feed during midsummer that its value in sustaining milk yields far outweighs the comparatively small risk involved in using it. Plant breeders are developing varieties with low prussic acid content.

Another good crop for midsummer grazing is the second growth of legumes which is made after the first growth has been harvested for hay. Dairy farmers in many sections of the country place much dependence upon such crops for midsummer use, particularly upon alfalfa, red clover, and birdsfoot trefoil. For the southern states, Johnson grass, bahia grass, millet, and lespedeza furnish much forage in midsummer. In the Northwest, giant kale has been found useful.

Many dairy farmers prefer silage as a means of supplying extra feed during the pasture season. In most cases the silage remains constant in composition and this is an advantage in the calculation

of suitable grain mixtures which are used to complete the feed needs of high-producing cows For low-producing cows, of course, it may not be necessary to feed grain mixture if silage adequately supplements pasture The use of grass-legume silage has rapidly come into favor for midsummer use because it is so nearly like pasture in feeding value

FIG 94 Supplementing low yielding pastures in midsummer by means of a small acreage of Sudan grass reduces the amounts of other roughage and grain mixture needed by dairy cows This picture shows two varieties of Sudan grass sweet at left common, at right.

The term soiling crops refers to crops which are harvested daily or several times weekly and brought to the cattle in barn or dry lot Crops used in this way cover a wide range, including such crops as winter rye, oats, corn, sorghum, Sudan grass, and a number of species of legumes The advantage of this plan is that larger yields of forage may be obtained than from a grazed crop and the cows are assured of sufficient forage each day The labor involved in preparing the land, planting, frequent harvesting, and feeding the crops is so great, however, that this plan of providing extra feed is used only to a limited extent

Fall Fall is the season when the feed needs of dairy cows are often overlooked Following periods of low rainfall, pasture forage is likely to be either dried-up grass or weeds In either case, the quality of the forage from a nutritional standpoint is usually low Cows often lose weight, and milk yields decline rapidly This is a critical time in the farm program When cows become thin in flesh as a result of prolonged underfeeding, both the percentage of fat and percentage of total solids in the milk may be lowered Then, too, underfed cows may crave unwholesome materials which are not ordinarily eaten Some of these, particularly acorns, hedgeapples,

and persimmons, contain tannic acid, an astringent substance which has a depressing effect upon milk yield. One of the most serious effects of underfeeding during the pasture season is that cows enter the winter feeding period without adequate body reserves. This usually means lower than normal production and sometimes also delayed reproduction until such time as these reserves can be restored.

REFERENCES

See references listed at the end of Chapter 8.

REVIEW

1. Why is pasture so highly regarded as a source of feed for dairy cows?
2. Explain the changes in yield and composition of grass pastures.
3. What are the advantages of legume pastures over those of grass pastures? The disadvantages?
4. List the merits of grass-legume pastures.
5. Why is supplementary feed needed when dairy cows are at pasture?
6. Discuss the kinds of supplementary feed needed, and tell how supplementary feed should be supplied during the spring.
7. What supplementary feeds are needed in midsummer, and what different plans of meeting these needs may be followed?
8. Explain the supplementation of pastures during the fall season and precautions which should be taken when pastures provide scanty grazing.

10

Studying the Composition and Preparation of Feeds

To be most successful, a person who wishes to operate a dairy farm should obtain a thorough knowledge of the fundamental facts about kinds and functions of nutrients in feeds, and also should learn how feeds are best prepared for consumption by dairy cattle

Determining the kinds of nutrients in feeds Plants and the feeds made from them consist of a large number of chemical compounds In making an appraisal of the nutritive value of a single plant or feed, it would be well-nigh impossible and also enormously expensive to carry out chemical analyses which would identify and measure each of these compounds For these reasons, methods have been worked out which enable the chemist to carry out analyses for groups of compounds which represent with considerable accuracy the feeding value of a plant or feed In making an ordinary analysis of a feed, the chemist determines the first six of the substances or groups of substances listed below A vitamin analysis of the feed is made only in special cases

Protein Protein is necessary in growth in the constant repair of the tissues, as a constituent of milk and in the development of the fetus Without protein these processes could not take place Protein rich feeds are usually the most costly of all common feedstuffs, for feeds carrying high percentages of protein are relatively scarce

Proteins are complex chemical compounds which are broken down in the digestive processes of the animal to much simpler chemical units known as amino acids The amino acids are absorbed from the intestinal tract into the blood stream and are recombined into the proteins of the muscles nerves, hair, horns, milk, etc Because of variations in chemical structure, each protein differs from other proteins in its characteristics and function even though all proteins are made up of amino acids Milk protein contains all the amino

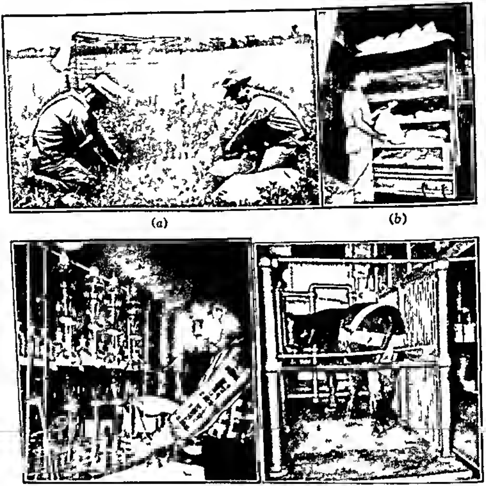
acids necessary for the rapid growth of young animals and the maintenance of mature animals, and these amino acids are also in such good proportions that the protein is efficiently utilized. For this reason, milk proteins are termed complete proteins. On the other hand, some proteins are incomplete as demonstrated by feeding experiments in which non-ruminant animals such as swine, fed rations containing only one particular protein, cannot grow or even maintain live weight. An example of an incomplete protein of this kind is gelatin. As pointed out in Chapter 8, however, the quality or characteristics of the protein of feeds is not a problem in feeding the dairy cow because of the action of microorganisms in the digestive tract. Rations made from good-quality roughages and simple grain mixtures satisfy the protein needs of the dairy cow provided the quantity of protein is ample. It is doubtful if there is any advantage from the standpoint of efficiency of utilization of protein in the use of grain mixtures containing a large number of ingredients.

The chemist determines the protein content of a feedstuff by analyzing the feed for its nitrogen content. Since feed proteins contain about 16 per cent nitrogen, the quantity of nitrogen is multiplied by the factor 6.25 to compute the amount of protein ($100 \div 16 = 6.25$). All of the nitrogen in feeds is presumed to represent protein, although in some cases, such as young growing plants, a part of the nitrogen is contained in simple compounds which have not yet been formed into protein. For these reasons, the proteins of feeds are referred to as nitrogenous substances and the term nitrogen is often used interchangeably with protein when reference is made to the nutrients in feeds.

Nitrogen-free extract. The chief source of energy in the feeding of farm livestock is the nitrogen-free extract and the fiber of feeds. These two classes of substances together make up the *carbohydrates*. The nitrogen-free extract consists principally of starches and sugars, but also includes a number of other classes of compounds closely related in composition to the starches and sugars. Farm grains contain from 50 to 70 pounds of nitrogen-free extract in 100 pounds of grain. Dry roughages, because of their high fiber content, contain only 30 to 50 per cent nitrogen-free extract. High-protein feeds, such as cottonseed meal and soybean meal, because of their large content of protein have only 25 to 35 pounds of nitrogen-free extract in 100 pounds of feed.

The chemist determines the amount of nitrogen-free extract in feeds by difference. The total weight of the sample of feed less

the sum of the protein fiber ether extract mineral matter, and water, is assumed to be the weight of the nitrogen free extract in the sample



(a) (b) (c) (d)

FIG 10 1 (a) Skillful sampling of a feed is the first procedure in determining its chemical composition and feeding value These men are sampling pasture forage (b) Samples of pasture forage hay and silage are dried in this large oven for 48 to 72 hours or until they cease to lose weight (c) Determinations of the amounts of nutrients in a feedstuff can only be made in a specially equipped chemical laboratory and by a trained technician This picture shows one of the procedures in determining the amounts of carotene in a feed (d) The digestibility of the nutrients of a feedstuff is learned from animal feeding trials Here a steer is being made ready for a trial in a respiration chamber

Fiber Pasture crops hay, and silage are characterized by the presence of fiber Commonly thought of as woody material the fiber forms the structural material of plants lending rigidity to the stems

branches, and leaves. The term fiber includes a large number of compounds closely related chemically, chief among which are cellulose, hemicellulose, pentosans, and lignin. All four groups of substances are resistant to digestive enzymes but the first three groups are digested through the action of the microorganisms which inhabit the digestive tract of ruminants. From 40 to 70 per cent of the fiber of well-cured legume hays is digestible. Lignin, on the other hand, is digested to a negligible extent. Since lignin is mostly indigestible, the presence of a large amount of lignin in a feed indicates low digestibility of the fiber.

Feeds high in fiber, such as the roughages, therefore, are less valuable sources of energy than are the farm grains. Barley, corn, rye, and wheat contain from 2 to 6 per cent fiber while well-cured hays have 25 to 40 per cent. Grain mixtures made up from farm grains and mill by-products ordinarily contain not more than 9 per cent fiber. A higher fiber content than this indicates that some feeds high in fiber, such as alfalfa meal or screenings, have been included in the mixture.

In determining the fiber content of a feedstuff, the chemist treats the sample with dilute acids and alkalies which dissolve most of the other substances, leaving chiefly the fiber.

Mineral matter. Many important body functions are dependent upon the presence of mineral matter. While it is commonly assumed that mineral matter is essential for the building of the skeleton, for the development of the fetus, and for milk production, minerals are required in nearly every chemical reaction which occurs in the body. The amount of mineral matter in roughages ranges from 4 to 9 per cent and in concentrates from 1.5 to 4 per cent.

The chemist finds the quantity of mineral matter in a feed by burning a weighed sample of it. The residue is mineral matter, or ash.

Ether extract. Some feeds, notably soybean seed and shelled corn, contain large amounts of oil. The oil of feeds serves much the same purposes in the body as do the carbohydrates. A pound of oil, however, furnishes 2.25 times as much energy as does a pound of starch or sugar. In determining the amount of oil in feeds, the chemist dissolves out the oil by treating the sample with warm ether. Because the ether also dissolves the coloring matter (pigments), waxes, and resins, this group of substances is properly termed ether extract rather than fat. The waxes, resins, and pigments, which are in the main indigestible, comprise only a small portion of the ether extract of

feeds but a considerable part of the ether extract of most roughages such as the legume hays

Water Water is present in all feeds Silage, roots, and fresh growing grass contain 65 to 90 per cent water, and even the farm grains after several months' storage contain from 10 to 12 per cent water

The amount of water in a feed is found by drying a sample of it in a constant-temperature oven for a specified number of hours or until the sample loses no more weight

Water is needed for the normal functioning of the body processes Digestion, assimilation of nutrients excretion of waste products, control of body temperature production of milk, and innumerable body reactions are dependent upon the presence of water

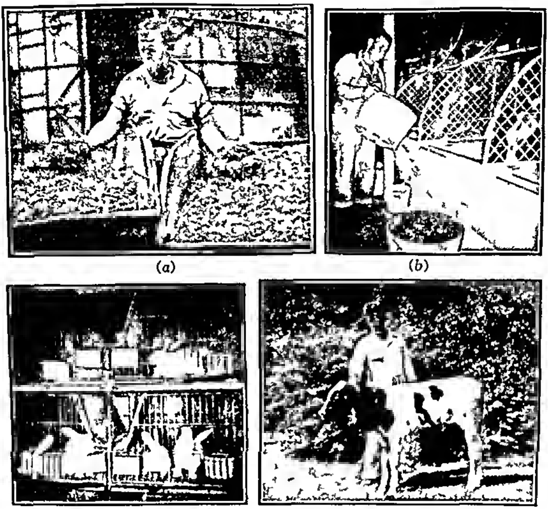
Vitamins The functions of the vitamins were briefly presented in Chapter 8 In determining the quantity of vitamins in feeds, special methods are employed because of the extremely small amounts present These amounts are too small to be expressed on a percentage basis Instead, the amounts may be given as the number of milligrams per pound (1 mg equals 1/450 000 part of a pound) By means of microbiological methods in which the growth of bacteria yeasts etc, are measured, it is possible to determine quantities of vitamins which are present in extremely small amounts The results may be expressed in terms of micrograms or parts per million A microgram is 1/1000 part of a milligram

Total digestible nutrients In Table 8 1 figures are given for both total protein and digestible protein There are also values for dry matter and total digestible nutrients In the case of alfalfa hay, for example, the amounts of digestible protein are less than the amounts of total protein and the figures for total digestible nutrients (abbreviated TDN) are less than those for dry matter Why these differences?

The body tissues utilize only those nutrients which are transported in soluble form or are in suspension in the blood stream Through the processes of digestion and assimilation readily soluble materials such as sugars and also a large portion of tough, fibrous feeds such as hay, are broken down to simpler compounds which can be taken up by the blood There is a wide difference in the extent to which various feeds are digested Feeds containing no fiber, such as milk and molasses are almost completely digested, while feeds high in fiber, such as hay, are relatively low in digestibility It is obvious therefore, that the value of a crop as feed depends not only upon

the yield in terms of bushels or tons, but also upon the number of pounds of digestible nutrients it supplies

The digestibility of a feed is determined by carefully executed trials with animals During the trial, feed intakes are exactly meas-



(a) (b) (c) (d)

FIG 10.2 (a) The final test of the worth of a feedstuff is learned from growth and production studies These cartloads of alfalfa silage look much alike (b) Feeding the silages shown in a to dairy heifers disclosed a difference between them in nutritive value (c) Rabbits and other small animals are commonly used in studies of the nutritive value of feeds (d) This calf was raised to 10 weeks of age in a chemical laboratory It was fed synthetic milk to learn the vitamin requirements of calves

ured and the feces collected Samples of both feed and feces are analyzed for dry matter, protein, mineral matter, ether extract, fiber, and nitrogen-free extract The amount of any nutrient digested and used by the animal tissues is the difference between the amount

of that nutrient consumed and the non absorbed portion found in the feces Following is an example of the method of calculating the results of a digestion trial with alfalfa hay

24 lb alfalfa hay consumed daily @ 15% protein	= 3 60 lb protein
44 lb feces excreted daily @ 2% protein	= 0 88 lb protein
Amount of protein digested	= 2 72 lb

$\frac{2\ 72}{3\ 60} \times 100 = 76\%$, the coefficient of apparent digestibility of the protein of this particular lot of alfalfa hay

Using the two values obtained in this trial for protein, namely, a content of 15 per cent protein in the hay and a coefficient of apparent digestibility of 76 per cent, it is found by further calculation (15 lb protein in 100 lb hay $\times$ 0 76 = 11 4) that 100 pounds of this hay contained 11 4 pounds, or 11 4 per cent, digestible protein In the same manner, the amounts of digestible ether extract, digestible fiber, and digestible nitrogen-free extract are calculated Because TDN is an expression which provides a comparison of feeds on an energy basis, and since fats have an energy value 2¼ times as great as that of carbohydrates, the extra value of fat is taken into consideration in making the computation, as follows

Digestible protein + digestible fiber + digestible nitrogen free extract
+ (digestible ether extract $\times$ 2¼) = total digestible nutrients

In these computations the term apparent is used because of the impossibility of making an exact determination of the undigested portions of the feed Besides these portions, the feces also contain some digestive juices, mineral matter, and other materials which are not truly undigested nutrients The coefficients of apparent digestibility as determined for feedstuffs, however, are approximately accurate and of great value in setting up rations for farm livestock

Why feeds vary in composition Manufacturers of protein supplements and other feeds which are sold under a guaranteed analysis make special efforts to keep the chemical composition of the feed constant and equal to the guarantee On the other hand, the chemical composition and nutritive value of farm grown feeds vary greatly from farm to farm and from year to year, depending upon a large number of factors Roughages vary more than the grains A few of the most important of these factors are briefly considered here

Stage at which harvested. Young growing crops are high in water content, but as they advance in development they become lower in this constituent. Thus, alfalfa-grass silage harvested at an early stage may have 20 to 22 per cent dry matter, whereas the same crop

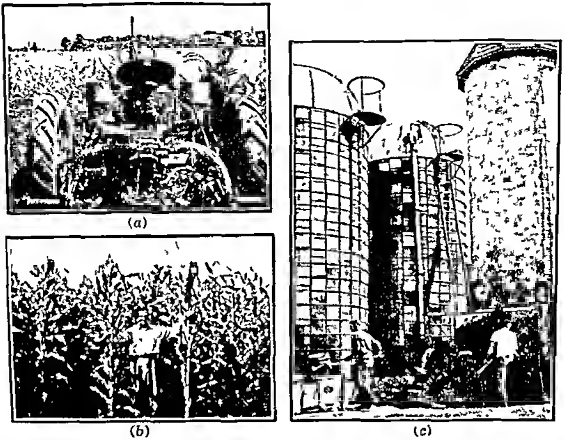


Fig 10.3 (*a*) Sidedressing corn with nitrogen fertilizer aids in maintaining the protein content at a high level (*b*) Strains of high-protein corn (left) may yield as many tons of forage as a well-known hybrid (U. S 13) at right (*c*) Silos holding about 25 tons were filled with different strains of high-protein corn in preparation for a feeding trial The man at the left collects a sample from each load

at later stages may contain 30 to 35 per cent dry matter. The dry-matter content of young pasture forage may be as low as 10 per cent, but as the forage approaches the seed stage, the dry-matter content may be as high as 40 to 50 per cent. Newly harvested corn and hay may have 25 to 30 per cent moisture, but after several months of storage the moisture content may decline to 12 to 15 per cent or less.

The stage of development greatly influences the protein content of forages and to some extent the protein content of grains. Both young legumes and young grasses may have a protein content of 30 to 35

per cent (calculated on a dry basis) With advancing development there is a gradual decline in the protein content and an increase in the percentage of fiber These changes are accompanied by changes in the proportions of the other nutrients

Methods of harvest Since the leaves of legume forage crops are two to three times as high in protein content as are the stems, methods of harvest which conserve the leaves aid in producing feed (hay and silage) with a high protein value Much of the protein value of the crop is lost when the leaves are shattered and left in the field

Quick curing is usually an aid in preserving the nutritive qualities of the crop Losses of nutrients may occur in haymaking when the curing process is prolonged because of windrows which are too large or when damp weather permits fermentation before storage Unnecessary exposure to the sun may destroy much of the carotene make the stems hard and cause the leaves to be so brittle that they powder when handled Rains and heavy dews which come after partial curing discolor the hay and leach out some of the nutrients Quick curing of the freshly harvested crop by artificial dehydration conserves most of the nutritive properties, including the carotene

Methods of storage Storage conditions may profoundly affect the nutritive value of feeds An excellent example of the effect of storing hay with excess moisture is found in an experiment reported by the Kansas Agricultural Experiment Station (J Dairy Sci, *23* 35) Two lots of hay which had become overheated and discolored because of high moisture content were compared with normal green hay The digestibility of the protein of the green hay was 67 per cent, of brown hay, 16 per cent and of black hay, 3 per cent The coefficients of digestibility for the dry matter as a whole for the three kinds of hay were 60 41 and 27, respectively

In humid climates the leaching by rain of nutrients from hay and other forage stored in unprotected stacks or other unsuitable storage places seriously lowers feeding values Mold or mustiness which develops because of too high a moisture content of the crop when stored lessens appetizing qualities The presence of rats, mice, birds, and insects in silos, hay mows and grain storage bins may adversely affect appetizing qualities and nutritive value

Productivity of the soil The productive ability of the soil on which a crop is grown has a profound influence upon the nutritive value of that crop Soils which have become depleted in their fertility levels because of long continued cropping produce grain crops which are low in nitrogen and phosphorus content The forages grown on such soils are also likely to be relatively low in these con-

stituents, although there are many exceptions to this general rule Usually legume hay crops grown on poor soils which have sufficient lime to produce a legume crop are short and leafy and because of their leafiness may have a protein content equal to or higher than that of a vigorous, tall-growing legume hay crop grown on a highly productive soil The phosphorus level of pasture forage grown on poor soils may be so low that a phosphorus deficiency may occur in cattle which receive no supplementary feed when grazing such pastures

The application of suitable soil treatments to soils of low fertility aids materially in restoring the mineral and protein levels of the crops to normal levels Interestingly enough, the use of nitrogen fertilizers on soils already well supplied with nitrogen has been found to enhance the protein content of such crops as pasture grass and corn (Table 10 1 and 10 2)

Table 10 1 *Content and Yield of Protein in Bluegrass Pasture Increased by Fertilization* *

Treatment	1st Year	2nd Year	3rd Year	4th Year	Average Four Seasons
		Percentage of Protein in Dry Matter			
Disked	16 2	21 7	16 0	16 3	17 9
Disked and manured	20 1	22 6	17 8	20 4	20 6
		Pounds of Protein per Acre			
Disked	249	267	132	70	718 †
Disked and manured	795	708	264	225	1992 †

* Bulletin 504, Ill Agr Exp Sta
† Total four seasons

Table 10 2 *Feeding Value and Yield of Corn Increased by Soil Treatment* *

	Untreated Land		Treated Land †	
	Corn after Oats	Corn after Red Clover	Corn after Oats	Corn after Red Clover
Corn yield, bu	22	46	83	101
Protein in corn, %	7 8	10 3	9 4	11 4
Protein in 1 bu , lb	4 4	5 8	5 3	6 4
Protein per acre lb	96	265	437	645

* Data from Morrow Plots Ill Agr Exp Sta
† Limestone phosphate and potash applied, legumes plowed under

Rainfall temperature and season may affect the protein content of oats barley, and wheat Variations may amount to 10 per cent or more Under drouth conditions, the calcium and phosphorus contents of pasture forage may decline to one half to two thirds of normal

Tables of feed composition differ Because of wide variations in the composition of feeds as explained above tables showing the nutritive value of feeds usually present average values The values shown in various books and bulletins may differ considerably, depending upon the individual values which make up the averages

Licensing feeds In most states the sale of milk by products protein supplements and ready mixed feeds is supervised or licensed by some branch of government such as the state department of agriculture or a state agency connected with the agricultural experiment station The manufacturer or distributor may be required to obtain a permit for the manufacture of each brand and to attach to each sack of feed a tag certifying its composition A yearly fee may be charged by the state for the permit and an additional charge may be made for each ton of feed sold In most cases the receipts from these sources are used to conduct an inspection service which has as its objective the protection of the customer against the use of harmful ingredients and fraud in the labeling of the feeds

In most cases feed manufacturers are required to print on the feed sack or on the tag attached to the sack a statement concerning the ingredients (corn, cottonseed meal salt etc) and the percentage composition of certain nutrients in the feed particularly the amounts of protein, fat fiber, and nitrogen free extract

Grinding feeds The thorough preparation of feeds for dairy cows is usually an economical and desirable practice especially when feed costs are high in relation to the market price of milk and it is necessary to figure cost of production closely Because the grinding of grains and of roughages differ markedly in the savings effected these topics are discussed separately

Grains The feeding of grain in ground form aids high producing cows to maintain high milk yields because their needed supply of digestible nutrients is obtained from a smaller quantity of feed than if the grains were fed whole Thus greater profits may be realized because of higher yields per cow and also through the saving of feed

In experiments at the Purdue Agricultural Experiment Station (Bul 372) it was found that 20 to 25 per cent of the whole oats and 30 to 35 per cent of the whole corn fed to dairy cows could be recov

ered in the feces. Trials at the South Dakota Station (Cir. 34) in which finely ground, medium ground, and whole grains (corn and oats) were fed to dairy cows, showed that in the case of corn, 100 pounds of medium ground, 96 pounds of finely ground, and 119 pounds of whole grain furnished equivalent feed values. With oats, less difference was caused by grinding, for 100 pounds of finely ground oats, 103 pounds of the medium ground, and 105 pounds of the whole grain gave equally good results. In both Wisconsin (Cir. 286) and the South Dakota trials, medium grinding was as effective as fine grinding and required considerably less power than fine grinding. It was also found that finely ground grain was less readily eaten than medium or coarsely ground grain.

The protein supplements used in grain mixtures for dairy cows are best purchased in the meal or ground form, rather than in the cake or nut form, in order to provide for more thorough mixing with the ground grains.

Newly harvested corn usually contains so high a percentage of moisture that in warm weather, or because of storage in a warm place, it soon becomes rancid after grinding. In using high-moisture corn in grain mixtures, grind only enough for one or two weeks' feeding.

Roughages. Investigations have shown that the grinding of hays, such as alfalfa and soybean hay, does not increase the completeness of digestibility. The digestive system of the dairy cow, through the process of chewing, of mixing coarse feeds with large amounts of liquid, of remastication (chewing the cud), of bacterial action (fermentation), and finally through chemical action of the digestive enzymes, seems to be especially well adapted to the digestion of large amounts of coarse, bulky feeds.

The grinding and also the chopping of coarse feeds, such as the hays and corn stover, however, does increase the proportion of the roughages consumed by dairy cows. Ground roughage is usually completely consumed, but this is also true of the best grades of fine-stemmed hays when fed whole. On the other hand, coarse roughages, such as soybean hay and corn stover, when fed in whole form are often refused to the extent of 10 to 33 per cent. The refused parts, consisting of the coarsest parts of the plants, are high in fiber and low in digestibility and nutritive value. In experiments conducted at the Illinois Agricultural Experiment Station (40th Ann. Rept., 148), dairy cows refused 14 per cent of soybean hay fed whole but only 2 per cent of the same kind of hay after grinding. Although the

apparent saving was 12 per cent of the hay fed, it was calculated that the gain in feeding value was much less on account of the low nutritive value of the stems, and amounted to only 5 per cent of the value of the hay Based on this finding one could afford to pay for grinding soybean hay only 5 per cent of its market value

The grinding of hay and the feeding of it dry has several drawbacks The dust which arises may cause irritation of the nasal passages of the persons doing the work and the dust is objectionable in barns in which high grade milk is being produced Often grain and roughage are ground together thus reducing the dust somewhat, but such a mixture cannot readily be fed in accordance with the needs of dairy cows producing moderate to large amounts of milk, for economical feeding practice requires that such cows be fed about the same amounts of roughage each day and that the quantities of grain mixture be changed with changes in milk yield

Recent experiments in the self-feeding of dairy cows carried out at the University of Illinois have shown that a reasonable degree of economy in feeding a mixture of ground grain and ground hay can be achieved if the proportions of hay and grain in the mixture are changed at intervals to compensate for declines in milk yield caused by advancing lactation

Some barns are equipped with feed rooms in which the ground hay may be placed in carts and thoroughly moistened with water before it is brought to tho stable where it is fed This procedure is effective in keeping the dust to a minimum

Instances have been reported in which the feeding of ground hay and grain in pelleted form as the only feed of dairy cows caused a marked lowering of the butterfat content of the milk As a preventive of such a result, the feeding of some silage or whole hay is recommended

The grinding and chopping of roughages is discussed further in connection with methods of making and storing hay (Chapter 25)

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REVIEW

1 List the substances or groups of compounds which are determined by the chemist in making a routine analysis of a feedstuff

2 Explain the functions in nutrition of each of the above substances or groups and also how the chemist makes the determinations

3 What is meant by TDN? Explain the procedure followed in making a digestion trial and in calculating the TDN value of a feed

4 Discuss the principal factors which cause farm-grown feeds to vary greatly

5 Explain the licensing of feeds

6 Discuss the advantages and economy of grinding (*a*) grains, (*b*) roughages, for dairy cattle feeding

11

Managing the Dairy Herd

Profits may be made or lost in the keeping of a dairy herd depending upon the kind of care which it receives. In order that a dairy cattle enterprise be a profitable one, it is necessary that intelligent supervision and close attention be given to the dozens of minor problems that arise in the daily routine operations. Directions for carrying out some of the details of herd care and management are given in the following sections.

Numbering stalls. It is essential that each cow in the herd occupy the same stall whenever she is in the stable and that she be known by a name or number placed in a conspicuous place on the stall. The name or number should be written or printed on both sides of a placard so that it may be read from either the front or the rear. The caretaker who knows his cows can then make certain that each cow enters her own stall when the cows are admitted to the barn, and also can quickly ascertain the herd numbers of the cows at feeding and milking times so that few mistakes will be made in the records.

Identifying cows. Unless the cow in the herd can be readily identified it is impossible of course to keep production records. The cows must be taught to enter their individual stalls so that each time they are admitted to the stable they will enter them of their own accord, but the caretaker should be able to recognize the animals quickly, so that if at any time any cows should exchange stalls he will instantly know it. The use of loose stabling systems and separate milking rooms or parlors makes record keeping more difficult than the keeping of cows in a stanchion stable in which they are also milked. A herd improvement program however is dependent upon the keeping of both production and breeding records and it is, therefore, essential that the herdsman be able to identify the cows no matter where they are located. Even though the caretaker may know the cows, it is desirable to have a permanent record of the identity of each animal in case of a change in milkers or of the sale of the cattle

Sketch color markings. Secure a supply of loose-leaf record blanks for keeping breeding records. These may be had from the dairy cattle breed associations, from various dairy farm journals, or from dairy equipment supply firms. Fasten several of the blank forms to a 10- by 12-inch board by means of thumbtacks. Take the board into the stable and sketch from the cows the outlines of the color areas. One person should hold the animal at the halter while the one doing the sketching sits on a chair or box so that his eyes are about on a level with the center of the animal's body. Indicate the color in the larger areas by an appropriate letter, such as B for black, F for fawn, etc. The dark areas may be added later by drawing straight lines through them. Be sure to enter the number or name of the animal on the sheet showing its markings.

For a cow of solid color, a description of the animal, including mention of any special features should be entered on the record blank. Some of the items to be mentioned in such description may be the shape of the horns, whether upturned, curved inward, or downward; color of tongue and switch; solid body color, whether light or dark shade.

Small photographs of individual animals pasted on the record blanks are superior to descriptions or color tracings, as they indicate the individual characteristics of the animals.

File records. Collect the records of the color markings and file them alphabetically according to the names of the cows, or numerically according to herd numbers. The records should be kept in a convenient place so that the breeding records, such as calving dates, etc., can be entered on them.

Marking cattle. There must be some means by which every animal in a purebred herd can be readily identified. This is also desirable in many grade herds, for accurate breeding records cannot be kept unless the herd number or name of each animal is known or can be quickly found. A good system of marking the cattle gives a buyer much greater confidence in the accuracy of the records. There are several different systems of marking cattle, at least one of which should be used in every purebred herd or large grade herd. The more important of these are: (1) trace color markings as above described, (2) place a strap or chain bearing a numbered tag around the neck of each animal, (3) fasten a numbered metal tag in the ear of each animal, and (4) tattoo the herd number of the animal in one of its ears.

Arranging the daily stable program On farms where men are employed to spend their entire time in caring for the dairy herd, regular hours for performing each operation are naturally adopted On farms where the men milking and caring for the cows are also employed in general farm work, there is a tendency to give the cows insufficient care and, especially during rush seasons, to neglect them In these cases it is important that a regular program be planned and followed out

Adopt a definite program The particular order in which many of the stable operations are performed is immaterial, but it is desirable that these operations be carried out at regular hours and the same order of procedure always be followed

Make periods between milkings uniform in length Best results are obtained when the cows are milked at regular intervals which will divide the 24 hours as evenly as may be practical Consider this fact in arranging the stable program

Feed regularly Cows learn to expect their feed at certain times Arrange the work so that the feeding will be done at the same hours each day Feeding is generally done near the milking hour, therefore, the dividing of the milking periods as evenly as practical, as suggested above, is also a benefit in distributing the feeding times uniformly through the day

Allow time for extra duties In planning the program allow a little time which can be spent in looking after some of the details of herd care, such as treatment of inflamed udders, care of cows at freshening, and changing record sheets Looking after the small details is necessary in successful herd management

Perform work quietly Dairy cows are highly sensitive animals and easily become disturbed or frightened Some breeds and some individuals within a breed are more excitable than others The presence of strangers or of dogs or other animals or the shouting of the workers or other loud noises may seriously interfere with that day's milk yields since frightened cows often 'hold up' their milk, that is, do not 'let down' their milk completely at milking time Sometimes only one fourth to one third of the expected yield is obtained from a nervous cow which is greatly disturbed The bringing of the cows from pasture to barn by a dog at milking time is generally a bad practice since the barking of the dog and the causing of the cows to run often has a serious effect on milk yields

Deciding on the time for freshening When pasture is abundant and cheap and the supply of feed for the winter months scarce or un-

usually high priced, it is often desirable that most of the cows freshen during the early spring months As a rule, pasture provides feed more cheaply than any other source, so that cows freshening in the spring make the most profitable use of pasture

The prices received for milk or cream during the different seasons must, of course, be taken into consideration also Even with higher feed costs during the winter months, the greater prices usually received for dairy products during the winter season may make it profitable to have the cows freshen in late fall or early winter

Some herds are expected to furnish a uniform amount of milk throughout the year If so, it is best to have about half the cows freshen in the spring and the other half in late fall or early winter The freshening of cows in midsummer is not a good practice on account of the danger of extreme temperatures greatly lowering milk yields

Calving at 12-month intervals has been found to be most satisfactory from the standpoint of a cow's lifetime yield of milk and is the goal sought by most dairy farmers in the management of their herds Calving once a year seems to provide for a rest period of adequate length for most cows and simplifies the planning of the herd management program Lengthening of the rest period beyond the usual 6- to 8-week allowance tends to increase the production during the immediately following lactation, but the practice of giving cows rest periods of three months or more, as was formerly the custom when maximum productions records were sought, does not necessarily increase the lifetime yield Extending the rest period beyond the usual length following the first lactation of a young cow is of greater benefit than is such a practice after a cow has reached maturity, presumably because of the opportunity afforded the young cow for growth and development during the rest period

Giving the cow a rest. Cows that naturally give but small quantities of milk tend to remain dry for three to four months of the year Cows of exceptional dairy tendency, on the other hand, may continue to give milk from one calving to the next This is a severe tax upon the vitality of the cow and should seldom, if ever, be permitted In order that some systematic arrangement may be made to secure as great an annual yield of milk as possible and still have the cows in good condition for the next freshening, follow the suggestions given below

Determine date of freshening Consult the breeding records and determine the dates on which the different cows are expected to calve

Make a list of these dates and also the dates on which the cows should be turned dry

In deciding upon the date for drying off a cow, consider her condition of flesh and ability as a milker Cows having good dairy ability should have six to eight weeks to rest and put on good flesh before calving Cows of only mediocre dairy ability do not need more than six weeks' rest, as a rule, although they usually are dry for a longer time Further, it is not necessary that they be in as high a state of flesh at calving time

Place the list containing the dates telling when the cows are expected to calve and when they should be turned dry in a conspicuous place, preferably beside the milk-record sheet In herds in which cows freshen in several different months of the year, it may be best to make out a new list on the first day of each month and post it alongside the new milk record blank.

Dry off the cow There is little difficulty in drying off cows that are not persistent milkers The milk yield declines to nothing even though regular milking is practiced For high producing, persistent cows the method given below, known as 'sealing the udder," is recommended

Milk the cow once daily for at least a week and until the milk yield has declined to not more than 30 pounds a day Two to three days before the udder is to be sealed, reduce the amounts of grain mixture and silage to one half the usual amounts To seal the udder, first wash clean, dry with a clean towel disinfect ends of teats with tincture of iodine, or other good disinfectant, and apply a small amount of collodion, using for the purpose a piece of surgical cotton or cotton bandage on a clean stick, or a glass swab fitted to the stopper of the bottle

Keep a cow with a large udder in a box stall until the swelling has subsided, because the swinging of a large udder which may occur when the cow is turned outdoors may cause injury Beginning with the fourth day after the udder is sealed, restore full feed to the cow Watch the cow closely and if the seal on one teat breaks milk out all four quarters and reseal, using the same precautions as before

This method of drying off cows should not be attempted with any cow showing evidences of mastitis, such as stringy or bloody milk.

Feed liberally Feed the cow during the dry period so that she will be in a good state of flesh at calving time If she is thin in flesh, begin to feed her heavily during the early part of the dry period and continue this procedure until after calving

Cows on good pasture need little or no additional feed during the dry period unless they are in thin flesh, in which event grain mixture should be fed in addition When pasture is not available, feed hay and silage liberally instead To cows in moderate flesh, feed 2 to 4 pounds of grain mixture daily in addition to roughage To cows in thin flesh, feed 4 to 6 pounds daily of a grain mixture such as the following

1 200 pounds ground corn, hominy feed, or ground barley
2 100 pounds ground oats or wheat bran

For a period of ten days to two weeks before calving, provide feeds that will exert a laxative effect on the cow Pasture furnishing plenty of green grass, or liberal amounts of legume hay or silage, will usually suffice, but if only dry feed is given and good legume hay is not available, feed a concentrate mixture such as one of the following

1 100 pounds ground oats, 100 pounds wheat bran
2 200 pounds ground oats, 100 pounds linseed meal
3 100 pounds each of wheat bran, and linseed meal

Feed 2 to 4 pounds of the mixture daily, depending upon the condition of the udder If the udder becomes badly caked, omit grain feeding and feed legume hay liberally, with a small amount of silage

Caring for the cow at freshening Careful attention to details as outlined below will aid in avoiding most of the troubles that frequently follow calving

Provide clean, well bedded box stall Clean the stall thoroughly, and put a liberal quantity of clean, dry bedding in it

Follow the breeding charts closely, and note when a cow is expected to calve As the actual date of calving may be as much as a week or ten days earlier or later than the expected date, one must watch the cow for signs of approaching calving As soon as it seems likely that she will calve in two or three days, keep her in a box stall instead of a stanchion, while she is in the barn

Keep cow warm Whenever a cow freshens during cold weather, careful attention must be given her Do not permit winter cold drafts to blow on her, nor turn her outdoors if the weather is cold If the stable is not warm enough to be comfortable keep a blanket on her for a few days An abundance of dry bedding also helps to keep her warm

Milk cow before calving only in emergency The udders of good dairy cows usually become large and swollen before calving It often seems that the cow should be milked in order to relieve the strain on

the udder but this should be done only as an emergency measure in cases such as may arise when high-producing cows have large and congested udders Under these conditions, milking before calving (termed prepartum milking), especially with first-calf heifers, is considered a good practice, since it aids in relieving the congestion and also helps to prevent a stretching, or breaking away, of the suspensory tissues which support the udder and hold it close to the body When these tissues break away the udder becomes pendulous Milking of a high-producing cow having a congested udder may be begun as soon as congestion is noted, and when needed may be done at short intervals Prepartum milking when judiciously practiced does not seem to reduce milk yields following calving

While the milking act aids in relieving congestion in the udder, an additional aid is gentle massage Immediately following each milking, massage the udder gently but firmly with the hands for 5 to 10 minutes, stroking from the lower front upward and backward However, heifers that show an unusual distention of the udder before first calving may safely be milked because they are seldom subject to milk fever Little milk is obtained the first day but beginning with the third day the milk yield rises rapidly and may reach 30 to 40 pounds daily before calving

Whenever a cow is milked before calving it is desirable to save the colostrum milk produced during the first two or three days for the feeding of the calf immediately after birth A good way to do this is to hold it in frozen condition until needed Warm to body temperature before feeding

Assist cow in calving only if necessary Most cows are able to give birth to their calves without assistance, and in such cases they should not be disturbed Occasionally, however, help must be given One should not attempt to assist a cow that is having difficulty in calving unless he is experienced or has the help of an experienced person

Give cow warm water A cow is usually thirsty after calving and would drink a large amount of cold water if given access to it In cold weather, however, she should not have it, as it might result in giving her a severe chill Give her water that has been warmed slightly, and for a few days provide water which is not colder than that coming from a deep well

Provide laxative feeds After the cow has calved, provide feeds that will keep her bowels moving freely See the directions given above for feeding during the dry period Continue to feed good-quality roughages liberally As rapidly as can be done without

causing too great congestion in the udder, increase the amounts of grain mixture up to the full quantity needed

Make sure that calf nurses It is necessary that the calf receive some of the first milk, or colostrum, within 30 to 60 minutes after birth Sometimes a calf is too weak to nurse without assistance When this is the case, assist the calf in standing and in grasping the teats If it is too weak to stand even with help, feed it some of its mother's milk from a bottle

Milking a cow at first calving Cows calving for the first time are often hard to milk on account of their timidity and fright This difficulty can largely be overcome by following the suggestions outlined below

Handle heifer before she calves Accustom the heifer to the presence and touch of a person by spending a few minutes each day, for two or three weeks before calving in handling her gently A good way to begin, if the heifer has never been handled, is by gentle patting or by brushing with a stiff brush Later, rub and handle the udder gently

Accustom heifer to stall If a heifer has not been kept in the stall which she is to occupy after she becomes a member of the milking herd, teach her to enter this stall and to occupy it for two or three weeks previous to calving In case a special milking room is used, accustom the heifer before calving to going through the routine procedure of having her udder cleaned and entering and leaving the milking stalls Even mature cows when milked for the first time in a milking parlor may be so frightened that they produce much less than normally for the first two or three milkings

Use gentle methods in milking and caring for cow Try to develop good habits in the young cow by gentle treatment Since the udder is tender at first calving, use care not to hurt the cow when milking her Refrain from shouting at the cows or striking them when letting them into or out of their stalls

Develop short teats The teats of some cows are so short at the time of first calving that it is difficult to milk them It is sometimes possible to cause the teats to become longer by stripping them gently every day or two for three or four months before calving There is danger, however, that this procedure, if continued too long or practiced too vigorously, may result in the formation of milk in the udder A common method of milking such a cow is to permit one or more calves to nurse her for three to four weeks after calving

This helps not only to lengthen the teats, but also to remove some of the inflammation from the udder

Preventing milk fever. This malady usually affects high-producing cows within the first few days following calving, although it may occur at other stages of the lactation period The affected cow may become restless and thrash wildly about After a time paralysis of the legs sets in, resulting first in an unsteady gait and finally in inability to rise The cow lies with her head turned close to one side

The cause of milk fever apparently lies in the removal of calcium from the blood for milk making at a more rapid rate than the blood calcium is replenished from the body stores Preventive measures and curative measures therefore consist in slowing down milk secretion and in supplying calcium from an outside source

As indicated above, one of the precautions against the occurrence of milk fever is not to milk the cow before calving except as an emergency measure If cows have had attacks of milk fever in previous lactations, a precautionary measure in subsequent lactations is during the first two days after calving to remove only enough of the milk from the udder to relieve the pressure

In case milk fever develops, do not milk the cow or allow the calf to nurse while the cow is affected The accumulation of milk with building up of pressure, slows the rate of milk secretion The most satisfactory treatment is to have a veterinarian inject into the blood stream of the animal a solution of calcium gluconate Recovery may occur within a few minutes to an hour Inflation of the udder is an emergency treatment which is based upon the finding that increasing the pressure within the udder slows milk secretion It may be applied by an experienced person The calcium gluconate treatment is generally preferred, however, because of less likelihood of infection than in the case of the inflation

Inflate the udder with compressed oxygen from a cylinder or with air by means of a milk fever apparatus The latter device consists of a small rubber inflation bulb, a metal cylinder containing absorbent cotton, and a metal milk tube, or teat cannula, which is inserted into the teat Before using the apparatus, boil the milk tube for 5 minutes or more and place fresh, sterile absorbent cotton in the cylinder Wash the ends of the teats and the operator's hands in a disinfectant solution Insert the milk tube into the teats, inflating each quarter in turn After inflating one teat, dip the milk tube into a disinfectant solution, such as rubbing alcohol, before inserting in

the next teat If necessary, tie a wide strip of soft cloth lightly about the teat after inflation to prevent the escape of air If necessary to tie the strips snugly, they must be loosened every 15 to 20 minutes to permit circulation of the blood and to prevent harm to the tissue Recovery may occur within an hour or two, or it may be necessary to keep the udder inflated for 24 hours or more

Milking cows more than twice daily. Milking more than twice daily does not materially increase the milk flow of low-producing cows, but it has a decided effect upon the yield of high-producing cows When labor is available, it may be a paying practice to milk high-producing cows three or four times daily The practice of frequent milking of cows being tested for A R and H I R records is not as common as formerly Many cows entered in these tests are milked only twice daily Studies of lactation records show that when production records are made under uniformly good conditions year after year, the records made on milking twice daily are as satisfactory a guide to the productive ability of a cow as are those made when milkings are more frequent (A detailed discussion of production records is given in Chapter 12)

Select cows to be milked more than twice daily A cow of one of the larger breeds, such as the Holstein, which is capable of producing more than 50 pounds of milk daily may well be milked three times a day If she is capable of producing more than 75 pounds a day, it may pay to milk her four times a day If she is a registered animal, it may be desirable to test her for Advanced Registry

The yield of Jersey or Guernsey cows producing more than 35 pounds of milk daily may usually be increased by milking three times a day When cows of these breeds produce upwards of 50 pounds daily, milking four times daily is recommended

Arrange regular hours for milking If the herd cows are milked regularly at 5 A M and 5 P M , the "three-time" cows may be milked at 5 A M , 1 P M , and 9 P M If it is impossible to have four different milking periods during the day, the three-time cows may be milked before the other cows in the morning, again at 12 noon or 1 P M , and then after the other cows at the 5 P M period When milking four times a day, arrange the milking periods at six-hour intervals, having two of the periods the same as for the regular herd cows, such as 5 A M , 11 A M , 5 P M , and 11 P M

Determine economy of procedure Keep a record of the amount of milk being produced daily by each cow before and after milking

three or more times daily Compute the value of the additional milk secured and decide whether or not the extra labor required should be spent in this way or in some other work

Preventing cows from kicking. In most cases, kicking can be prevented by making sure that the cow is not hurt or frightened A good procedure is to handle the heifer before first calving until she becomes accustomed to the touch of a human being and is docile and unafraid This is the best insurance against her becoming a kicker after calving

A cow usually kicks because she is hurt or frightened The udder may be tender after calving or the teats may be sore Unusual noise and the presence of strange persons or dogs are also causes of kicking Try to find the cause and remove it Do not strike or kick the cow, as this makes matters worse When a cow persists in kicking after all relief measures have been tried, secure a set of hobbles and fasten them on her legs just above the hocks and adjust the connecting chain so that the cow can stand but cannot kick Do not tie a rope about the cow's body, as this may result in injury

Preventing cows from sucking Some cows develop the habit of sucking themselves or other cows This reduces the milk yield, of course, and should be prevented

Secure a metal anti-sucking device and fasten it in the cow's nostrils *Such a device is usually effective Another method is to have* the cow wear a halter, the nose strap of which is covered by another strap through which sharp pointed nails project outward The former method is generally preferred

Keeping cows comfortable Cows should be protected from extremes of temperature, drafts etc, and kept as comfortable as possible by the methods outlined below

Keep temperature of barn moderate The appetities of cows are sharper when the weather is cold than when it is hot, but neither extreme of temperature is desirable Try to maintain a uniform temperature so far as possible, preferably between 40° and 55° F

Prevent drafts from striking cows Provide plenty of fresh air by means of a well-designed ventilation system, as discussed in Chapter 27 When the weather is cold, do not permit direct drafts from doors or windows to strike the cows

Use sufficient bedding Bedding is sometimes scarce and expensive, but it is generally a necessity, since inflammation of the cows' udders is often due to their coming in contact with cold floors Whenever possible, use enough bedding to cover the stall floor completely

Provide shade in summer. Cows suffer from extreme heat as well as from extreme cold. Provide shade trees or a covered shed open on all sides, and give the cows access to the shade for several hours during the hottest part of the day in extreme weather. Some herds are kept in darkened barns during the day in the hottest weather and turned out to pasture at night. Such a plan is not practical unless the barn can be kept fairly cool and well ventilated.

FIG 111 High-producing cows require protection from the sun on hot days

Provide good drinking water. A supply of pure, clean drinking water is essential to the health of cattle and must be available at all times.

Provide the dairy herd with clean, pure water. That coming from wells, clear running streams, or lakes is usually satisfactory, but one should not expect cattle to drink water from muddy streams or stagnant pools. The water in stagnant ponds is especially undesirable, since it generally contains slimy growths and may contain disease organisms When the herd is supplied with water from the same source as that used by the family, one can rest assured that the quality of the water given the animals is satisfactory.

Clean water tanks and bowls frequently. Large water tanks soon become filthy, especially in warm weather, if not cleaned frequently. Every three or four weeks, drain out the water and scrub the sides and bottom thoroughly by means of a stiff broom Rinse thoroughly.

Place 3 or 4 pounds of hydrated lime and 1 or 2 ounces of copper sulphate in the tank to keep down the growth which generally occurs. Clean automatic water bowls as often as necessary to keep them free from hay or other feed that falls into them.

Keep water above freezing temperature. Cows do not drink as much water when it is ice cold as when it is warmer; then, too, drinking ice water may chill them severely. Warm the water, by means of

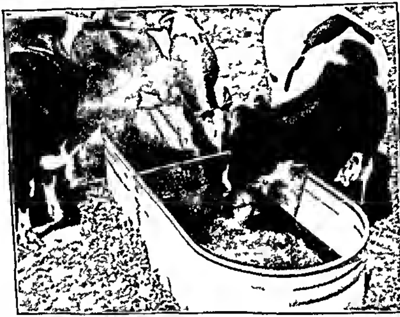

FIG. 11.2. A supply of clean fresh drinking water should be available at all times. (Agricultural Photo Library.)

a tank heater, so that its temperature is 50° F. or higher, or provide an underground tank and gravity or pressure system so that the water is always above freezing.

Protecting cows from flies. Lessened milk production during the summer is generally thought to be due to the annoyance of flies. Insufficient feed is probably a more important cause, but flies may be responsible for a part of the loss. Keeping flies off the cows during the milking hour makes milking easier, and keeping them away from the milk lessens the chances of its becoming contaminated with disease germs.

Keep barn and lots clean. In warm weather house flies and stable flies lay their eggs in moist materials, including manure heaps, damp bedding, and decaying vegetation. Horn flies find manure droppings

in pastures a favored medium for egg laying Depending upon temperature and moisture conditions, the eggs hatch within three to five days and the adult fly stage is reached within 10 to 14 days Unless checked in their multiplication by sanitary measures and other means, the fly population around dairy barns mounts to enormous numbers within a few weeks

The first and most important procedure in combatting flies is to keep the premises clean and to destroy or render innocuous all potential breeding places Each day thoroughly clean the gutters, litter alleys, and rear parts of the stalls and sprinkle over them a coating of hydrated lime Some board of health regulations forbid the use of loose-housing shelters during the summer months Remove all manure and bedding from such quarters as soon as the fly season begins (which often coincides with the beginning of the pasture season), and spread a heavy coating of hydrated lime over the entire area Keep cattle from these quarters until killing frosts in the fall have destroyed most of the flies

Scrape the surface of the exercising yards and lots in which there is manure and fill any mudholes with fresh soil Paving the exercise yards with concrete or other impervious surfacing material is an effective aid in fly control At least once weekly haul the manure from stable, yard, and lots and spread thinly on the fields so that it will dry out Thoroughly clean and haul away with the manure any accumulated feed or filth in the corners of mangers and feed bunks and around barn drains, as well as decaying stack bottoms and silage refuse If it is not possible to spread the manure on the fields frequently, deposit in heaps at least one-fourth mile from the barn

At least once a year, give the inside walls and ceiling of the stable or loose-housing shelter a thorough coating of whitewash Paint interior walls and ceiling of milk house with an enamel paint which will withstand washing

Prevent the breeding of flies in manure droppings in pastures by means of a toothed harrow set nearly flat This procedure benefits the pasture as well as being a means of fly control

Destroy flies A number of sprays which are so powerful in their action that flies are killed when they walk on walls or cows sprayed with them are now available One of these, DDT (dichloro-diphenyl-trichloroethane), may be used on buildings and cattle other than dairy cows, but it is not recommended for use on dairy cows or in buildings where milk is produced or handled Even minute amounts of DDT in milk may be toxic to humans DDT is sometimes used

in the dusting of fields of silage corn for the control of corn borer, but small amounts of this substance may find their way into milk if the treatments are applied within 60 days before harvest

In some areas flies have become resistant to DDT with the result that other and more effective compounds have been developed One

FIG 11.3 As cows pass through this treadle sprayer they are automatically sprayed with a fly repellent

of these which is recommended by the Bureau of Entomology, U S Department of Agriculture, for the spraying of both dairy barns and dairy cows is known as methoxychlor This material may also be used for the control of insects on forage crops It is considered a safe material when used in accordance with directions Flies walking on cattle or walls recently sprayed with this material are killed In spraying the stable, apply the spray to walls, ceiling, stanchions, pens, and other places where flies alight Spraying must be repeated about every three weeks or whenever the insecticide loses its potency Do not use on walls which have been newly whitewashed

Both DDT and methoxychlor may become ineffective after a time because flies frequently become resistant to them In such cases some other product such as lindane or chlordane may be employed Neither of these should be used on cows and only lindane may be used in dairy barns Commercial sprays consisting of these or similar compounds are also available Spray all buildings (except interiors of dairy barns and milk houses) where flies roost Repeat in three to five weeks Avoid contaminating feed and water with these sprays Further, do not use these or similar insecticides on manure piles and other fly-breeding areas To do so might permit the development of resistant strains of flies Activated pyrethrin sprays are effective against horn flies and stable flies and may be used on cattle or as space sprays

Biting flies such as horn flies, stable flies, and horse flies, may be controlled by the use of an automatic sprayer placed in a covered chute or runway through which an animal must make at least three round trips a week The device may be located in a lane between pasture and milking barn, or between barn and water tank As the animal steps on a treadle in the chute, it is sprayed by an insecticide in the form of a fine mist

Poison bait consisting of a powerful insecticide mixed with molasses is also a useful means of reducing the fly population The bait is diluted with water and sprinkled on floors where flies gather

Fly screens covering the windows of cow stables are of doubtful value since they may prevent the escape of flies from the interior The use of screens on doors and windows of milk rooms, however, is generally advantageous since flies are attracted to warm milk Flies may be kept from the milk strainer or milk cooler by means of a current of air from an overhead electric fan

Protecting from lice. Under crowded conditions, calves and young cattle are subject to infestations of lice Occasionally cows also become infested These are seldom found in cattle continuously pastured but are most often observed during the months when cattle are closely stabled

Because of the itching of the skin caused by the lice, cattle rub themselves on fences, trees, and corners of barn or stalls, or lick themselves Patches of the hide which are bare of hair often result

Effective treatment during warm weather consists in thoroughly wetting the entire body with a spray made from methoxychlor or other approved insecticide In winter, dust the parts most commonly affected (neck, top of head, back, and tailhead) with methoxychlor

powder Spraying or dusting must be repeated at intervals since the eggs (nits), which are attached to the ends of the hairs, hatch in 10 to 18 days

If the buildings and lots are badly infected it is useless to treat the animals unless the infested quarters are also treated Clean thoroughly and then spray the stalls, pens and fences with a solution of methoxychlor or other approved insecticide in the manner recommended for fly control Whitewashing is also beneficial

(a) (b)

Fig 114 (a) Clipping long hairs aids in summer comfort and lice control Removing as much hair as this is not recommended for loose-housing barns (b) Clipping udder flanks and rump is an aid in clean milk production (Courtesy Sunbeam Corporation)

Grooming cows Use brush and curry comb daily Give the cows a thorough brushing each day by means of a stiff brush, and remove manure clinging to the thighs or flanks by means of a curry comb Grooming not only keeps the coat of the cows in a more healthful condition but also aids in the production of clean milk

Electric grooming brushes and vacuum cleaners for the grooming of cows may be used instead of hand brushes and curry combs The clipping of flanks, thighs, udder, and upper portion of the tail simplify grooming and make possible the keeping of cows in much cleaner condition than when cows have long, heavy coats of hair

Experiments designed to study the effect of grooming upon milk yield have not shown a demonstrable increase in yield as a result of this practice, but studies of the relation of cleanliness of cow to bacterial content of the milk produced have shown that keeping cows

clean is a distinct aid in the production of milk having a low bacterial count

Dehorning cows. It is recommended that the horns should not be permitted to grow on dairy cattle unless the animals in all probability

FIG 11.5 Electric grooming brushes with rotating brush or suction make possible a thorough grooming job (Courtesy, Sunbeam Corporation)

will be exhibited in the show ring Directions for preventing the growth of horns on calves are given in Chapter 14

The dehorning of heifers or cows is carried out in the same manner as directed for the bull (Chapter 13)

Trimming hoofs. The hoofs of cows that are pastured and that normally travel over a considerable amount of hard ground or paved exercise lots usually wear down about as fast as they grow If cows are kept closely stabled during the winter months, however, the dewclaws and hoofs may become so long that they cause an abnormal posture both in standing and in walking In extreme cases, lameness may result

Carry out the trimming operation in a room having a wood floor or by placing the animal in a specially designed stall having a plank floor Shorten the dewclaws by clipping off the points With ham-

mer and chisel, trim off the fronts of the hoofs (toes) to give them a full rounded appearance Be particularly careful not to cut into the sensitive tissue (quick) since such cuts may cause soreness or serious infections After trimming the toes lift one foot at a time, bending the leg backward with the sole of the foot facing backward and upward and place the foot on a wood box or block Using a hoof knife and rasp trim off the extra growth on the sole, again being careful not to cut too deeply Smooth the hoof to a well rounded appearance by means of the rasp

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Circular 180 The Production of Dairy Cows as Affected by Frequency and Regularity of Milking and Feeding 830 Once a Day versus Twice a Day Feeding of Dairy Cows

REVIEW

1 Why is it essential that arrangements be made which will enable the caretaker of a dairy herd to identify each animal and to keep a record of the animals identity? Explain in detail how such arrangements can be made and records kept

2 Why is it desirable that a definite stable routine or program be adopted? Outline a good stable program

3 How long a rest period should be given dairy cows? Explain a good procedure for drying off a cow and for feeding her during the rest period

4 Outline good procedures for caring for the cow at freshening time

5 Explain the procedures used in milking a cow following her first calving

6 Explain good procedures for the (*a*) prevention (*b*) treatment of milk fever

7 Is it desirable to milk cows more than twice daily? Discuss

8 What procedures may be used to prevent cows from kicking?

9 What considerations should be kept in mind when providing comfort for cows in (*a*) winter, (*b*) summer?

10 How can a supply of good water be provided for dairy cows?

11 Outline good procedures for the control of flies in dairy stables and milk houses

12 Explain procedures for freeing cattle from lice

13 Why should cows be groomed? How is grooming best done?

14 Give detailed directions for trimming the hoofs of dairy cattle

12

Determining Milk and Butterfat Yields

Ascertaining the production of each cow in terms of pounds of milk and butterfat is one of the most important of all operations connected with the management of the dairy herd In well managed herds the whole program of breeding feeding and care is built upon a knowledge of these records

Keeping production records a necessary job In order that the importance of record keeping be fully understood and appreciated some of the outstanding reasons for performing this task in a capable manner are presented in the following sections

Profits dependent on yields The greater the yield of milk per cow (within certain limitations) the larger are the profits Further under normal price conditions profits increase at a more rapid rate than do milk yields Low producing cows often fail to meet the expense of feed labor and other costs and the lower the production the greater become the possibilities for loss A knowledge of the amount of milk produced is therefore the first step in good herd management

Records needed for culling The most rapid method of increasing the average yield of cows in the herd is to cull out the cows which are lowest in production Carefully made production records not only are a dependable guide but also the most reliable source of information for carrying out this procedure Replacement of the cows culled out may be made by raising heifers from the best cows or by purchase of better cows or heifers No matter what system of breeding or management is followed in an effort to improve the milk yields of the herd the rate of improvement is bound to be slow unless the low producing cows are systematically removed from the herd

Records the basis of herd improvement Regardless of whether an increase in production is effected through a breeding program or by purchase of new female stock someone must raise the new animals

some cows are likely to receive more grain mixture than they need while others are underfed. For economy in feeding, records of the daily or approximate average daily production (computed from a weekly or monthly record) is essential. Then too, some cows may never reach the high level of production of which they are capable because the feeder lacks a record of production which shows him the response of the cow to grain mixture feeding and which would enable him gradually to bring the cow up to her full milk-producing capacity.

Records an aid in advertising. Production records are of especial importance in the keeping of registered dairy cattle. Breeders of such cattle make much use of production records when purchasing breeding stock, particularly herd sires. The records form the basis for advertising the breeder's herd and are in most cases the principal feature which attracts buyers to a particular herd in preference to another.

Pedigrees, the chief medium for advertising registered dairy cattle, are built around records of production as the main feature. A dairy cattle pedigree which contains few or no production records has little merit. In recent years, it has become customary to include type classification ratings and occasionally also show ring honors in pedigrees, but production records are still the backbone of a good dairy pedigree. Most sales of registered dairy cattle are made largely on the basis of pedigree.

Records increase sales value. The prices obtained for registered breeding stock are greatly influenced by the production records of the animal itself or of its near relatives. The unusually high prices received for some sires, amounting to many thousands of dollars for a single animal, are in most cases paid because of the outstanding production records of his daughters, sisters, or dam.

Grade dairy cows with good production records also sell for higher prices as milk cows than do grade cows without records. Records made in dairy herd improvement associations are accorded much recognition and add to the sales value of grade cows sold as herd replacements.

Selecting best form of record. Production records may be obtained by the caretaker or with the assistance of outside agencies. A brief description of the principal methods is given in the following sections.

Private records. The keeping of records by the owner or caretaker has several advantages as compared with the making of these records

exclusively by an outside agency. Among these are (1) a smaller cash outlay, (2) the opportunity of recording milk weights at less than monthly intervals, and (3) postponing the recording for any cow for a day or two in case of illness or other abnormality on the regular recording day. Although records made for the complete milkings of one day each month are satisfactory for the purpose

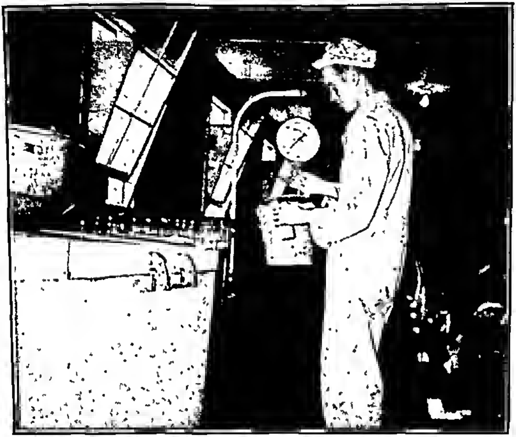

FIG. 12.2. Weighing the milk of each cow is of paramount importance. Taking samples for butterfat tests is also desirable.

of estimating the yearly yield, daily recordings are much better in that they are an excellent guide (1) to feeding grain mixtures, (2) to sudden changes in milk yield brought about by illness or incomplete milking, and (3) in maintaining the interest of the workers in the care of the herd.

The weighing of the milk of individual cows is difficult or impossible with some types of pipeline milkers, unless special provision is made at the time the milker is installed which will make possible the weighing of the milk yielded by each cow. In some pipeline installations the milk from a cow first enters a milk pail or glass receiving

jar suspended from a scale The weight of the complete milking of the cow is thus easily read and recorded before the milk is drawn through the system to the milk can or cooling tank

D H I A records A dairy herd improvement association (usually referred to as D H I A) is a cooperative association of a group of dairy farmers which has as its primary objective the obtaining of production records of the dairy herds of its members The area covered by the association is usually limited to a county or portions of two adjoining counties As a rule not more than 25 herds are enrolled in one association so that the tester, or supervisor, may make the milk recordings and tests at each member's farm one day each month In some states bimonthly testing is practiced, thus permitting a larger membership in one association

The D H I A work is under the direction and general supervision of the state colleges of agriculture in cooperation with the U S Department of Agriculture The testers are trained at the colleges and employed and paid by the association

Under the usual plan of operation, namely, monthly record making, the tester performs the following services

1 Records weight of milk for each cow during a 24-hour period

2 Makes a butterfat test from a composite sample of each cow's milk

3 Computes for the current month the value of milk or butterfat for each cow and entire herd

4 Records amounts of feed consumed and value of feed for each cow and herd

5 Calculates returns over feed cost for each cow and herd

6 Records pertinent herd data, including dates of calving, mating, and eartag numbers, and progeny data including birth dates, sex, and sire

7 When requested, supplies feeding information

8 Forwards to state college records of each herd including monthly summary of milk and butterfat production and feed cost and also completed lactation records for use in proven sire testing program

9 In case a member has registered cattle and is enrolled in Herd Improvement Registry, the tester when requested may also report this test

10 At annual meeting of his D H I A, reports to members on progress of work

D H I A testing has increased in popularity until, at the time of this writing the associations, which are in operation in 48 states,

Alaska, Hawaii, and Puerto Rico, have an enrollment of more than 1,300,000 cows, or approximately 5 per cent of all milk cows in these areas The growth of the work is one of the best evidences of its value to its members The keeping of production records by these associations has made possible and also greatly expedited and expanded the program of proving sires, one of the beneficial features of D H I A work Among the other important benefits derived from D H I A membership is use of the records in the culling of low-producing cows and the selection of heifers from the best cows to be raised as herd replacements Further, the level of production of herds enrolled in D H I A work has shown a steady increase (Table 12 1), thus indicating improved financial returns

Table 12 1 *Dairy Herd Improvement Association Work Shows Progress* *

Year	No of Cows Tested	Average Production	
		Milk, lb	Butterfat, lb
1906	239	5,430	215
1910	25,000	5,730	227
1920	203,472	6,241	247
1930	507,549	7 642	303
1940	676,141	8,133	331
1950	1,088 872	9,172	370

* Dairy Herd Improvement Association Letter, U S D A , Vol 27, No 8

A R and H I R tests Owners of registered dairy cattle may apply to their dairy cattle breed association for either A R (Advanced Registry) or H I R (Herd Improvement Registry) tests The American Jersey Cattle Club uses the term Register of Merit and the Brown Swiss Cattle Breeders' Association employs the term Register of Production rather than A R for their official tests All five of the leading dairy cattle associations recognize the H I R test

The A R test is under the direct control of the dairy cattle breed associations, but it is supervised by the state colleges of agriculture within their respective states The cows to be tested are chosen by the owner at his discretion With his application for testing, the owner remits an entry fee to the association for each cow to be tested, but pays the college of agriculture for services of the tester

In conducting the A R test, a preliminary dry milking is made exactly 24 hours before the final official milking, and the record

period covers one day's production each month[1] Daily milk weights are kept by the owner throughout the month In case the production of a cow for a particular test period should exceed certain limits set by the breed association or should otherwise deviate from the expected yield a tester must be sent to make a retest of that cow's production A R records may cover a 305 day period (10 months) or a 365 day period Various designations are given the records, depending upon the number of daily milkings and age of cow

When a herd is enrolled in the H I R test all registered cows in the herd must be tested and their records reported to the breed association This rule prevents the owner from selecting only the highest-producing cows for testing No preliminary dry milking is required in the H I R method and the owner is not obligated to record milk weights during the other days of the month These arrangements permit the tests to be taken and reported by the D H I A tester, provided the herd owner is a member of such an association If the owner is not a D H I A member the tests are taken monthly by an official tester sent by the state college of agriculture

Evaluating production records The size of the production record of an individual cow is influenced by a large number of conditions Because of this, a number of correction factors have been worked out to make possible a comparison of production records of different cows on a fairly equitable basis even though the conditions under which the records were made differed considerably One of the principal uses of the correction factors is in the proving of sires, where it is often necessary to compare records of both young calves and mature cows and of cows milked twice daily with those milked three or more times daily For some of the conditions influencing the amount of milk produced fairly reliable correction factors are in use For other conditions such as differences in feed and care, no satisfactory correction factors are available All correction factors are derived from averages of large numbers of records and may not apply exactly to individual cases Any one cow or herd may differ considerably from the average because of individual circumstances such as illness of a cow or improved conditions of feeding for the entire herd brought about by an improved pasture program

Age of cow Cows produce considerably less milk during the first lactation period than they do during a lactation after reaching maturity Under usual conditions the yearly production of a dairy

[1] Upon application of the owner the American Guernsey Cattle Breeders Association permits either monthly or bimonthly testing in both the A R and H.I.R divisions

cow continues to increase with each lactation up to about 6 years of age; after 8 years of age there is a slight but gradual decline.

All of the dairy cattle breed associations and the U S Department of Agriculture use correction factors for converting the production records of young cows to a mature-age, or mature-equivalent (abbreviated ME), basis. It is estimated that cows of the Ayrshire, Guernsey, and Jersey breeds which calve at 2 years of age produce about 79 per cent as much as they do at 6 years of age; Holsteins produce about 73 per cent as much, and Brown Swiss approximately 65 per cent as much. A set of correction factors for converting production records to a mature-age basis is given in Table 6 2.

Factors which take into account the decline in production which takes place after 8 years of age have also been published. Cows calving at ages of 8, 9, 10, 11, and 12 years produce, respectively, approximately 99, 98, 96, 94, and 91 per cent as much as they did following their calving at 6 years of age.

Length of lactation. As indicated above, production records are commonly reported either on the basis of 305 days (10 months) or 365 days In case it is desired to convert a 365-day record for a Jersey cow to a 305-day basis, the record is multiplied by the factor 0 87 to correct it to the amount which would theoretically have been produced had the cow been milked for only 10 months and then been given a dry period The shorter record has increased in favor during recent years because it permits a calving interval of 12 months. In order that a cow continue in milk production for 365 days, it is necessary that the cow be allowed a calving interval of 14 to 16 months.

Number of daily milkings. On most dairy farms, cows are milked twice daily, but when the daily yield greatly exceeds the usual amount, a condition which frequently occurs shortly after calving, cows are sometimes milked three times a day for the first four to six weeks. On farms where registered dairy cattle are kept and H.I.R. tests are being made, milking three times a day (abbreviated 3×) is fairly common, and when A.R. testing is under way, milking may be done on a 3× or 4× daily plan. Because production of high-yielding cows is larger when milking is done on a 3× or 4× basis than is the case with 2× milking, the following correction factors are sometimes used:

To convert records made by 3× milking to a 2× basis, multiply by 0.833 For example, a record of 500 lb butterfat on 3× milking: 500 × 0.833 = 416 5 lb on 2× milking

To convert records made by 4× milking to a 2× basis multiply by 0 741 For example a record of 600 lb butterfat on 4× milking 600 × 0 741 = 444.6 lb on 2× milking

Differences in test—FCM method Because of differences in the test of milk of cows within a breed and of milk of the various dairy cattle breeds, production records are commonly computed in terms of pounds of butterfat This plan is preferable to reporting the records in terms of pounds of milk only since the milk of various cows differs widely in its butterfat content High testing milk contains much more energy per pound than does low-testing milk The reporting of production records in terms of pounds of butterfat only, however, is unfair in cases where there is a difference in test of the different cows, especially in the case of cows having extreme differences in tests, such as Holsteins and Jerseys The use of figures showing only the butterfat neglects the energy value of the other solids of milk, a most important item One hundred pounds of skim milk furnishes about one half as much energy as does 100 pounds of whole milk In producing 400 pounds of butterfat a Holstein cow yields about 11,770 pounds of milk while a Jersey cow in producing the same amount of butterfat produces only about 7550 pounds of milk

To overcome these differences and make possible the comparison of production records on an equitable basis Professor W L Gaines of the Illinois Agricultural Experiment Station devised a method which he designated as the fat-corrected milk method (abbreviated FCM)[1] The formula is (0 4 × yearly milk yield in pounds) + (15 × yearly fat yield in pounds) The use of the method may be illustrated by converting the yields given in the above paragraph to an FCM basis

(11 770 × 0 034 = 400 lb butterfat yearly)

11 770 × 0 4 = 4 708
400 × 15 = 6 000

10 708 lb FCM

(7,550 × 0 053 = 400 lb butterfat yearly)

7 550 × 0 4 = 3 020
400 × 15 = 6 000

9 020 lb FCM

[1] Bul 308

It is obvious that the Holstein cow in producing a unit amount of butterfat yields milk containing a larger amount of energy than does a Jersey cow producing milk containing the same amount of butterfat.

Considering other factors affecting yields. In addition to the factors having an important bearing on yields for which adjustments or corrections can be made, there are a number of other conditions affecting yields. For most of these, no satisfactory correction factors have met general acceptance.

Feed and care. In the purchase of animals on the basis of records, either made by a cow herself or by near relatives of the animal under consideration, it is best to know something concerning the conditions under which the records were made. In the making of A R records, advantage is sometimes taken of special conditions of feed and care to obtain the highest possible yields. When this objective is sought, (1) only the highest producing cows are selected for record making, (2) breeding is delayed to provide a calving interval longer than the normal period of one year, (3) the cows are heavily fed during a long dry period to make them fat at calving time, (4) the cows are milked 3× or 4× daily, and (5) the cows are given especially good care and are heavily fed throughout the year. Production records made under these conditions may be 20 to 40 per cent larger than those made under conditions of ordinary feed and care.

Stage of gestation. Cows which remain open, that is, do not become pregnant after having calved, continue to produce milk for a longer time and at a somewhat higher rate of yield than do those which are mated and conceive within three months after freshening. The yield of milk for a yearly lactation is thus larger when the next calving is delayed than when it occurs at regular intervals of about 12 months.

The maximum daily yield of milk of a cow is usually reached within four to six weeks after calving. From that time forward, there is a gradual and steady decline in daily yield until about the fifth month of pregnancy, when the decline becomes somewhat more rapid. This decline is attributed to two factors, namely, withdrawal of nutrients from the mother for the development of the fetus and the effect of hormones which inhibit milk production. The hormonal effect is presumably a provision of nature for reduction in yield of milk and restoration of body reserves in preparation for the lactation which is to follow within a few months.

The dairy cattle breed associations recognize the depressing effects of gestation on milk production in their rules which include a calving

requirement for certain classes of records. To qualify for these classifications, a cow must calve within a given number of days following the completion of milk recording. The objective of the rules is to have production records made under conditions which will establish true productivity. Unusually long calving intervals mean the birth of fewer calves and lower lifetime yields. There are, however, no recognized correction factors which may be applied to records made under delayed-calving conditions to convert them to a 12-month calving basis.

Other factors. A large number of factors other than those described in this chapter affect yields of milk. Some of these are discussed in Chapters 20 and 21.

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REVIEW

1. Why is it necessary that production records be kept in a well-managed dairy herd?
2. Explain how and why production records are used in culling cows from the dairy herd.
3. In what ways do production records form the basis for herd improvement?
4. How do production records provide a basis for feeding?
5. Explain the use of production records in advertising.
6. Do production records increase sales value of dairy cattle?
7. List the advantages of keeping private production records.
8. Explain the organization of a dairy herd improvement association, and list the services performed by the tester.
9. Explain A.R. and H.I.R. tests; list the advantages and adaptability of each form of record.
10. For what different conditions connected with the making of production records are correction factors used? Explain the use of each of these factors.

13

Feeding and Managing the Dairy Bull

The increased use of artificial insemination in recent years has relieved many dairy farmers of the task of raising and caring for herd sires. It is likely, however, that the natural breeding method will not be wholly replaced, particularly in areas outside intensive dairy regions. Because of the greatly extended use of bulls employed for artificial breeding work, where a single bull may have not 15 to 50 offspring, as in the case of a sire used in a single herd, but hundreds or even thousands of offspring, it has become increasingly important that bulls raised as herd sires be fed and managed in the best possible manner.

The feeding and care of the dairy bull are usually given much less attention than they deserve. In but few herds is the feeding of the bull given as much thought as the feeding of one of the best cows; yet much of the success of the herd depends upon the treatment of the herd bull. Since bulls of the dairy breeds are expected to grow to be about 50 per cent heavier than the mature cows, they must receive plenty of feed of the proper kind. The loss of the breeding powers of bulls is doubtless more often due to a lack of proper care and management than to old age.

Feeding the bull calf. It is common practice, in dairy herds containing grade cows, to dispose of the male calves for veal when three to ten weeks of age. In herds in which the calves are purebred, however, the male calves, as well as the females, are raised The directions here given for the raising of the bull calf are intended to apply particularly to the calf of good breeding being raised to head a dairy herd.

Feed young bull liberally. The bull calf should be fed in much the same way as the heifer calves. The feeding program, however, should provide for feeding the young bull more liberally, especially after three or four months of age. After this age has been reached, endeavor to keep the bull calf growing as rapidly as possible by

supplying good pasture, high-quality roughage and a suitable grain mixture As in the case of heifers, a grain mixture which is appropriately used with a particular kind of roughage for milk cows is also well adapted for the bull

Caring for the young bull In addition to liberal feeding, the bull calf requires exercise, proper housing and special care

Separate young bull from heifer calves When the bull calf reaches the age of 5 to 6 months, he should not have opportunity to mingle with heifers or cows that are not pregnant Should all the cows or heifers in the herd be in calf however the bull calf under 1 year of age may be permitted to run in the pasture with the herd

Provide exercise and good quarters Keep the bull calf in good condition by plenty of exercise and good shelter During the winter, provide a roomy, warm box stall, opening on a yard into which the bull may be turned on pleasant days The stall should be kept dry and clean and should have an abundance of light In summer, the young bull may be kept in a separate lot or pastured with other bulls or with a herd of pregnant cows Some shade during extremely hot weather is desirable

Ringing the bull As a matter of safety, a ring, by which the bull may be led, should be inserted in his nose The ring should be placed in the nose when the bull is from 9 to 12 months of age Select a ring of non-rusting material, such as copper gun metal, or brass The ring for the young bull should be of light or medium weight When the bull becomes well grown, this ring should be replaced by one of heavier weight and larger size It is well to keep an extra ring on hand in case of breakage or loss of the one in use

Before attempting to place the ring in the bull's nose, fasten the bull securely in a strong stanchion, making sure that he cannot lunge forward upon the persons inserting the ring It is best to tie a large animal by means of a strong halter as well as to place him in a stanchion

The trocar and cannula is the best instrument for making the opening through the cartilage that forms the dividing wall between the nostrils The trocar, cannula, and ring should be boiled just before they are to be used, or placed in a disinfectant solution for a few minutes

Hold the nose firmly with one hand and push the trocar, with cannula in place, through the nasal cartilage at a point a little above the lower end of the nostril, where the cartilage is thin Withdraw the trocar, leaving the cannula projecting through the nose Insert

the open end of the ring in the small end of the cannula and remove the cannula from the nose, at the same time drawing the ring through the nose. Close the ring and fasten it securely by means of the screw. If the ring or the head of the screw has become roughened, it should be smoothed with a file or sandpaper.

If this operation is performed in a barn that does not have a smooth, clean floor, spread a canvas or blanket below the bull's head to prevent loss of the screw, in case it should be dropped.

Dehorning the bull. Unless the bull is particularly valuable as a show animal, he should be dehorned. He can then be handled with much less danger, and there is less likelihood of his breaking through his enclosure. If possible, prevent the growth of the horns of the bull calf as soon as the buttons can be plainly felt, which is when the calf is one to two weeks old. This should be done by applying a caustic or by means of an electric dehorner, as described in Chapter 14. If the growth of the horns was not prevented when the bull was a calf, the horns are best removed when the bull is about two years old. Since the operation of removing the horns from a strong bull is attended with considerable risk of injury to the men doing the work, it is best to obtain the services of an experienced person for this job.

Leading the bull. Every precaution should be taken to prevent the bull from injuring persons or animals, or doing any other damage, while he is being led about.

At an early age, train bull to be led. Begin teaching the bull to be led while he is still young. When 4 to 6 months of age, he may readily become accustomed to the halter. Lead him about the barnyard, making him familiar with different conditions, such as the noise of machinery and the sight of other animals.

Always use staff for mature bull. Do not attempt to lead a well-grown bull without a staff attached securely to a ring in his nose. The bull must be trained to the staff as well as to the halter. In leading the bull with the staff, always walk at his side and never in front of him Keep his head held high, as a bull can do little damage with his head in that position. Watch him constantly while leading or holding him.

Whenever a bull that is known to be vicious, or one that behaves in a dangerous manner, is to be led, always employ two men. Each man may use a staff, each staff being attached to a separate ring in the bull's nose. A common method of leading such bulls is for one man to use a strong staff attached to one nose ring, while the other man

uses a heavy strap snapped into a second ring In either case, the men walk on opposite sides of the bull, keeping abreast of him, and forcing him to hold his head high

When a vicious bull, or one whose disposition is unknown, is kept in a yard or box stall, make the animal secure before entering the stall to attach the staff This may often be done by enticing the bull to the manger by means of some grain mixture, and then snapping a rope or strap in his ring The bull may then be tied or held by an attendant before the keeper enters the stall with the staff

Treat every bull with caution Whenever a bull is being led, use caution and have respect for his great strength Accidents with bulls are not always due to the animals being vicious but may result from their becoming frightened Do not take chances when leading a bull but use every precaution to safeguard yourself and others

Controlling the use of the bull Too early or too frequent use of the bull must be avoided, in order to obtain the best results

Do not allow the bull to be used for service before he is 12 months of age, unless he is much above the average in growth and development

Until the bull matures (3 years of age) the number of females with which he may be mated during a season may be as many as he is months of age The services of the young bull should be distributed over as much time as possible it is preferable that they should not occur oftener than twice a week

Mature bulls may be mated with larger numbers of females than immature bulls, particularly if the breeding season extends throughout most of the year Under such conditions, one bull may be sufficient in a herd of 50 to 60 cows

The too-frequent use of the bull is often responsible for the failure of cows to become pregnant and for an early decline in the vigor of the bull

Do not permit the bull to run with the herd except under the conditions described above Keep him confined in a box stall, yard, or pasture, by himself Permitting the bull to run with the herd during the breeding season not only makes it impossible to determine the date upon which cows are due to calve, but also may seriously reduce the vigor of the bull

Feeding the mature bull. The bull should be kept in good flesh by liberal feeding of concentrates, with ample amounts of good roughage

Provide roughage of good quality Provide pasture for the mature bull, if possible He should not be expected to secure all his feed from pasture, but he will be much better off if he has fresh green grass If it is not possible to provide pasture, take a small amount of fresh grass or green crops to the bull frequently

During the time pasture or green crops are not available, feed good-quality legume hay in liberal amounts The assumption that the feeding of silage to bulls of breeding age is harmful has been shown by carefully conducted experiments to be erroneous The experiments showed that silage may be freely fed without harmful results, so far as the reproductive powers of the bull are concerned

Feed concentrate mixture liberally As a rule, grain mixtures must be fed to keep the bull in good flesh and condition Concentrate feeding is especially important during the breeding season

Feed 3 to 5 pounds of grain mixture daily depending upon the bull's size and condition Another rule is to feed 3 pounds of grain mixture daily for each 1000 pounds of live weight, increasing this to a slightly heavier rate during the breeding season If the quality of the roughage is poor, it may be necessary to feed more than this amount Larger amounts are needed during the breeding season than when the bull is not being used for service

The kind of grain mixture being used for the milking herd (Chapter 8) is also suitable for the herd sire, providing both classes of animals are receiving the same kind of roughage The feeding program for the bull, however, must be such that an ample amount of protein is provided, particularly during the breeding season In case the roughage consists of dried-up pasture or poor-quality hay lacking green color, add 1 to 2 pounds of dry vitamin A-D concentrate to each ton of grain mixture

Housing and exercising the bull On many farms little importance is attached to the kind of quarters and the opportunity for exercise given the herd bull Too often the bull is tied closely in a dark, dirty shed, with no outdoor exercise Since the bull has a much greater influence on the success of the herd than even the best cow, he should be kept in the best of health and condition by means of comfortable quarters and regular exercise

Provide comfortable stall Provide a large, roomy box stall or separate building for the herd bull For a Jersey or Guernsey bull a stall 10 by 10 feet in size may be sufficient A mature bull of the other dairy breeds needs a stall 10 by 12 feet or larger Do not keep a herd bull confined constantly in a stanchion or tied in a

narrow stall It is desirable to have a stanchion in the stall, however for confining the bull while the stall is being cleaned or while the staff is being attached Further, do not keep a bull tied in his stall by means of his nose ring as this makes his nose so tough that it is difficult to lead him with a staff If it is necessary to keep the bull tied provide an extra heavy neck strap made of several thicknesses of leather, with a large iron ring and heavy chain

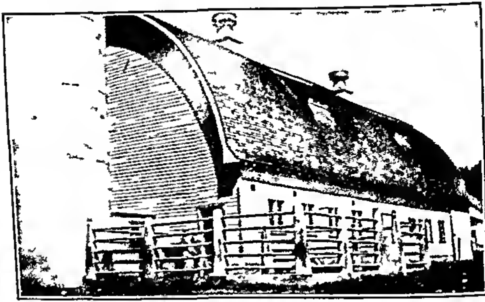

FIG 131 In cold climates the herd bull is often housed in a stall in the barn and given access to an adjoining exercise lot

For northern climates it is best to have the bull's box stall in the part of the barn where the milk cows or young stock are kept so that he may be comfortably warm in winter In sections where the climate is not severe a separate barn or open shed may be suitable

Although barns in which the milking herd is kept should be provided with a good floor, such as concrete, the separate bull barn or open shed for the bull may have only a clay dirt floor, if there is good drainage To prepare a clay floor, scrape the ground free from straw, sticks and loose surface dirt and cover with a 5 or 6-inch layer of fresh clay which is free from stones While the clay is damp tamp it solid and allow to dry for a day or two before using. A stall or yard paved with cinders is not desirable, because the cinders cause sores between the hoofs

Keep stall well bedded. In the summer, use only enough bedding to keep the bull from becoming badly soiled, unless bedding is cheap and plentiful; in this case, of course, it may be used freely at all times. In winter, it is essential that plenty of bedding be used, so that the bull will not have to lie on cold or damp floors. An ample supply of bedding helps to keep the bull comfortable in cold weather.

When the stall has a dirt floor, bedding can be saved, and at the same time the stall can be kept in first-class condition, by using a layer of shavings on the ground with a good covering of straw on top.

Arrange yard or paddock adjoining stall. Arrange an exercising yard or paddock leading out from the bull's stall, so that he can be turned out for exercise daily or whenever the weather is not too stormy. By having the yard in direct connection with the stall, unnecessary leading of the bull is avoided

The yard need not be paved, but good drainage should be provided When the bull is permitted to stand in mud puddles or filth, footrot or other diseases may occur. Grade the yard, filling depressions and providing sufficient slope so that water drains off quickly. With some types of soil, paved yards are desirable. Gravel consisting of large smooth stones, brick or concrete, may be used for paving. Finely crushed rock and cinders are not good for this purpose.

Do not fail to provide a strong wall or fence about the yard.

See that the bull exercises regularly. Some bulls take enough exercise when given the freedom of the yard or pasture adjoining their stall. Other bulls under the same conditions will not move about much, and some way must be found to make them exercise A barrel or stump for the bull to bunt about may be placed in the yard. Some bulls, when young, may be trained to work and used just as an ox is used in drawing loads.

Caring for vicious bulls. Many bulls of good breeding are sold for slaughter when but 3 or 4 years of age, either because they are difficult to handle or for fear they will soon become vicious and dangerous. While there is great danger in handling bulls that have ugly or vicious dispositions, some of the well-bred animals could be retained longer if suitable arrangements for housing them were available. The following suggestions for providing such arrangements have been tried out successfully.

Provide strong quarters. The stall in which a vicious bull is kept and the fences surrounding the yard in which he takes his exercise should be made so strong that there will be no danger of his break-

ing out When once a bull has broken through a fence, he often tries to repeat the performance Box stalls in the barn may be equipped satisfactorily with a modern bull pen made of heavy steel tubing Such pens are strong, may be readily cleaned, and permit the caretaker to observe the actions of the bull

When the bull stall is to be constructed of wood, line it on the inside with 2-inch plank, bolting or nailing the plank to strong posts

FIG 132 Strongly fenced exercising lots are needed for mature bulls This barn accommodates a number of bulls kept for artificial insemination purposes

securely set in the ground or fastened to the framework of the building

Make the exercising yard equally secure It may be enclosed by solid walls of stone, brick, or concrete Another plan is to use large cement posts with horizontal openings 10 to 12 inches apart through which iron pipes of 1¼ to 1½ inches inside diameters are placed In making such a fence, thread each piece of pipe and join the pieces firmly by couplings or unions Use not less than five horizontal bars of pipe, and have the posts not more than 8 feet apart The total height of the wall or fence must be 5 or 6 feet

Wooden fences are satisfactory if strongly constructed and kept in repair In constructing wooden fences, use posts 9 or 10 feet in length and 6 inches or more in diameter, and set them about 6 feet apart Nail the poles or plank (2- by 6- or 2- by 8-inch pieces) on the inside of the posts so that the fence is smooth on the side next to

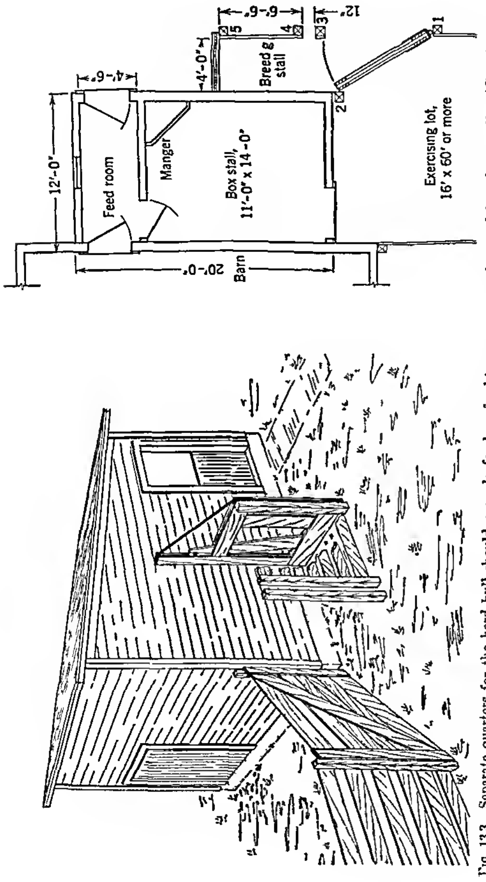

Fig 13.3 Separate quarters for the herd bull should provide feeding facilities, exercising lot, and breeding stall (Cir 460, Ill Agr Exp Sta)

the bull Place the poles or plank so close together that there is no chance for the bull to get his head between them, and so near the ground that he cannot get his head below them

If the stall is provided with a wooden manger place one or more planks above the manger so that there will be no possibility of the bull s getting his feet in the manger or climbing out of the stall by way of the manger

Arrange breeding pen The need for handling the bull may be greatly lessened by arranging a breeding pen as part of the bull's quarters Such an arrangement is shown on page 191

Retaining a good bull. It is worth while to devise ways of using a good bull for as many years as possible In grade herds in which the milking herd is replenished by the purchase of cows, little attention is given the quality of the herd bull, and when his usefulness ceases he is sold for beef In herds in which calves are raised to maturity, however, much care must be exercised in the selection and use of the bull if good calves are to be produced Most dairy herds are of such size that not more than one herd bull is kept, and here the problem is to secure another bull whenever the daughters of one become of breeding age, which is about every two years, in order to avoid inbreediog in the herd

Many bulls are sold before their real worth has been discovered The first daughters of a bull usually do not complete their first lactations until their sire is about 5 years of age Unfortunately, relatively few bulls are kept to that age, and if the daughters are later found to be exceptionally good milkers, it is usually then too late to get the bull back

There are several ways in which a bull may be kept in service until his real value is known One of the most practicable is by use of a cooperative bull association in which the several bulls owned by the association are rotated among the members at intervals of one to two years Such associations became numerous in dairy regions but their numher has declined with the expanded use of artificial insemination Anotber plan is for two or three neighbors to exchange their bulls every two or three years, or, in the case of valuable purebred herds, some of the more promising bull calves may be loaned or leased to smaller herds for a few years In large herds where two or more herd bulls are kept, inbreeding may easily be avoided for some time, and bulls may therefore be retained for a much longer time than if there were but one bull at the head of the herd

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REVIEW

1 Describe good procedures for the (*a*) feeding and (*b*) care of the bull calf

2 Give directions for the ringing of a bull

3 How can a bull be dehorned? Describe the procedures to be followed in using one of the methods

4 What precautions should be taken in leading a bull? How should a bull be trained so that he can be safely led?

5 Give rules governing the use of the bull in service

6 Outline a good feeding program for a mature bull

7 Describe the construction of comfortable and safe quarters for a bull

8 How can exercise for a bull be provided?

9 Describe various plans which may be followed for retaining meritorious bulls over a period of years

14

Raising the Dairy Calf

The improvement of a dairy herd through the use of better sires is impossible unless the calves can be successfully raised Too often a large amount of capital is invested in an outstanding sire only to have the venture fail because of the loss of a high proportion of his calves within a few weeks after their birth Good methods of calf raising therefore, go hand in hand with a herd improvement program

Some 5 million to 7 million calves are raised each year by dairy farmers of the United States to replace cows removed or lost to the herd because of low production, old age, accidents, disease, death, or other causes In some of the intensive dairy sections where the raising of calves and heifers is expensive because of the lack of cheap pasture and other forage, herd replacements are purchased from dairy farmers living in areas where calves and heifers can be grown to milking age more cheaply Thus some dairy farmers find it advantageous to raise none of their dairy calves, others raise all or most of them, while the majority of dairy farmers raise their heifer calves primarily as replacements for their own herds Where the last-mentioned plan is followed, opportunity is afforded for raising only the calves which have greatest promise of improving the herd

There is no more important detail in the care and management of a dairy herd than the raising of the calves Well grown, vigorous animals are those that have had excellent care from birth Undernourished, stunted calves often though not always, may be grown out into large animals by careful feeding, but calves that are thrifty, vigorous, and large when 6 months of age are much more resistant to disease and have a much better opportunity to develop into large, useful animals Undersized calves may be due to false ideas of economy on the part of the feeder, as well as to a lack of knowledge of the principles and practice of successful calf raising

Learning essential qualities of good ration The young calf needs a ration which not only furnishes all the nutrients necessary for maintenance and growth, but which is also strikingly different from rations of mature animals in that it must be highly digestible Milk

contains chiefly proteins, sugar, butterfat, minerals, vitamins, and water, all of which are readily digested and utilized by the young calf. Milk proteins are distinguished from most proteins of vegetable feeds in that they supply all of the needed amino acids in suitable proportions for the making of rapid growth in young animals. Milk is, in fact, the only natural feed so far known that satisfactorily nourishes the calf from birth until it is several weeks old. While many attempts have been made to devise synthetic milk or milk substitutes which will replace milk in calf raising, only a few of these products have closely approached milk in value. Several of the most promising present-day products contain some milk or one or more milk constituents. A 'synthetic' milk developed at the University of Illinois (J. Dairy Sci., *30* 87–94) which was employed as sole feed for the successful raising of experimental calves up to 40 weeks of age, was built around casein, the principal protein of milk, as the source of protein.

The digestive tract of a calf but a few days old cannot digest rough feeds such as hay, oat hulls, and corn stover, which are high in fiber content. It is important, therefore, that calves be fed milk in the amounts required until they are able to utilize coarse feeds.

Caring for calf at birth. Too often, the calf is left to shift for itself at the most critical period of its life. Lack of care during the first few days usually means the loss of a large number of calves that might easily have been saved.

Provide good quarters to receive calf. Watch the breeding records of the herd in order to know when calves may be expected to be born. If a gestation table is not handy, figure that the calf will be expected in 281 days from the date of conception. Since the gestation period in cattle may range from 275 to 287 days, watch the cow closely for signs of impending parturition. Prepare a box stall a day or two in advance. Clean the stall thoroughly, removing all bedding and scraping and sweeping down the sides of the stall if manure or filth has gathered on them. If any calves having white scours have been in the stall previously, clean the stall thoroughly and then disinfect it with a strong solution of lye water (8 ounces of lye to 5 gallons of water). In case the stall has a dirt floor, or if the weather is so cold that the stall would not dry, a liberal amount of air-slaked lime may be used instead.

After the stall has dried, place a large amount of clean, dry bedding in it. Keep the stall well bedded and as dry as possible. Avoid drafts so far as possible, although fresh air is desirable.

Calves born at pasture during warm weather usually require less attention than those born in the barn, although if the weather is rainy or cold there is danger of infection or chilling

Keep calf warm Be sure that the calf is dry and warm If it shivers cover it with a blanket or a number of feed sacks Provide an abundance of dry bedding

Assist calf in nursing if necessary In case the calf is unable to stand and nurse its mother give it some assistance Sometimes two persons are necessary if the calf is very weak Make certain that the calf receives some of the first milk or colostrum It should have an opportunity to nurse 4 or 5 times during the first day Strong calves left with their mothers may nurse 10 to 15 times during a 24 hour period Nature's plan apparently provides for the young animal to receive its feed in small portions given frequently

Make sure calf receives colostrum milk The first milk secreted by the cow after calving termed colostrum is beneficial to the calf in helping its digestive tract to function properly and also in transferring to the calf large amounts of protein minerals and vitamins Colostrum is produced only after a rest period of suitable length Cows which have been milked several times immediately before calving yield milk following calving which is nearly normal in composition Hence if a cow is milked prepartum save the first few milkings by freezing for the first feedings of the newly born calf In case the mother's milk is unsuitable for feeding because of its being lumpy, stringy, or bloody as a result of mastitis infection of the udder supply the colostrum from a cow having a healthy udder

The protein of colostrum consists of a much higher proportion of globulin than does normal milk The globulins of milk are presumed to be the source of antibodies which aid in protecting the calf for a short time after birth against infections

Colostrum is much more concentrated than normal milk Not only *is the protein content from 3 to 5 times as high as that of normal* milk but also the mineral content is much greater Colostrum may be termed fairly rich in some of the minerals in which normal milk is too low when used as the only feed for calves Among these minerals are copper iron magnesium and manganese

Colostrum also contains 5 to 15 times the amount of vitamin A found in normal milk depending upon the character of the ration given the mother during the rest period The vitamin A concentration of colostrum may be brought to a high level by supplying feeds

especially rich in carotene content for several weeks prior to parturition An illustration of the great value of vitamin A in the development of the young calf is shown by experimental work in which it was found that whole milk can be replaced by skim milk at an early age *provided the skim milk is supplemented* by large amounts of vitamin A (see section on vitamins for calves) and some grains to furnish additional energy

Colostrum is also superior to normal milk in having a considerably greater amount of several other vitamins which have been found essential in the growth of dairy calves, including riboflavin, choline, thiamine, and pantothenic acid

Finally, colostrum acts as a laxative to free the digestive tract of fecal material

Disinfect calf's navel As soon as possible after the calf has been given the first attention necessary, disinfect the naval Paint the raw, exposed part of the naval cord with a 30 per cent solution of tincture of iodine using a small brush or piece of cheesecloth If iodine is not available, use a 5 to 10 per cent solution of a coal tar disinfectant, placing this in a cup and holding the cup up under the calf so that the navel cord is immersed in the solution Repeat the treatment daily until the cord becomes dry

The disinfection of the navel is essential as it helps to prevent disease germs from entering the body of the calf at that point

Teaching the calf to drink This is an operation that requires considerable patience as some calves are slow in learning to take milk from a pail Teaching the calf to drink at an early age, however, is a profitable investment of time, since this makes possible better control of the milk consumption It also is an aid in ensuring an adequate liquid intake, for in hot weather calves need water in addition to their quota of milk

Separate calf from its mother When the calf is 1 or 2 days of age, place it in a pen where it will not have access to any cow Calves that are weak may need to be left with their mothers for 3 days or even more but strong vigorous calves may usually be separated from their mothers at 24 to 36 hours of age If they remain with their mothers longer than this there is danger of their obtaining so much milk that indigestion results Also they are more readily taught to drink if separated at an early age

Use patience in teaching calf Pour about a quart of mother s milk into a clean pail used for feeding calves, keeping account of the

amount Back the calf into a corner and bring its nose into contact with the milk This is best accomplished by allowing the calf to suck the fingers of the feeder so that the head may be guided into the pail After the calf has obtained a few mouthfuls of milk remove the fingers although whenever the calf lifts its head out of the pail it is necessary to repeat the procedure When the calf has consumed

Fig 14 1 The use of nipple pails is a simple method of feeding milk to calves which do not readily drink from a pail Thorough cleaning of the pails each day is essential (Agricultural Photo Library)

the amount of milk first offered pour in the rest of the milk that is to be given at that feeding

Use as much patience as possible for the calf may choke if its *nose is forced into the milk It is sometimes* necessary to omit a feeding before the calf can be taught to drink

Use nipple pails if preferred On some farms it is preferred to feed the young calf during the first 3 or 4 weeks of life from a nipple pail that is a pail equipped with a rubber nipple which the calf sucks rather than from ordinary pails The nipple pail method is presumed to have an advantage in that the calf takes the milk more slowly when fed in this way and thus is less likely to have digestive upsets

When nipple pails are used, rinse them thoroughly after each feeding At least once daily, remove the nipples, thoroughly wash both nipples and pails, and then sterilize (Chapter 22)

Feeding whole milk It is important that the milk given to a calf be in good condition and at the proper temperature Much of the success in calf raising is dependent, too, upon the amount of milk given and the frequency of feeding

Provide milk from the calf's mother Use milk from the mother of the calf for feeding during the first few days, unless the milk is not suitable on account of its being thick, stringy, or too rich Milk that is rich in fat, such as Jersey and Guernsey milk, sometimes causes digestive disturbances If this occurs, dilute the rich milk with skim milk, using one part of skim milk to two parts of whole milk In the absence of skim milk use warm water in the same proportions After the calf is 5 to 7 days old, milk from the herd may be substituted for the mother's milk

Feed milk immediately after it is drawn Feed the young calf at once after securing the milk from its mother, when the milk will be at about body temperature Milk cools rapidly in winter and if fed when cold may cause indigestion, especially if the milk is cold at one feeding and warm at another At milking time, save enough for the immediate feeding of the calf and also for the other feedings which are to be given during the interval between milking hours

At other times, warm milk to body temperature Be careful to warm the milk that has been saved for the feedings between milkings to about body temperature (100° F) To warm the milk place it in an 8- or 10 quart pail Set this pail in a large pail containing 3 to 4 quarts of hot water Stir the milk constantly until it reaches the desired temperature Use a thermometer, preferably of the floating type, if available It is not advisable to heat the milk by putting hot water into it, as this dilutes the milk too much Electric heating coils may be employed for warming the milk, but they are best used for heating the water in the container in which the milk pail is placed Placing the electric coil directly into the milk is likely to cause the coil to become coated with a covering of milk which is difficult to remove

Keep milk in good condition Place the milk that has been saved for the other feedings in a can, and set in a cooling tank This is necessary in summer to prevent souring and in winter to prevent freezing Keep the can covered to prevent flies and dust from getting into the milk It is best not to feed sour milk to young calves, al-

though this often may be done successfully with calves 5 to 6 months of age Try to have the milk that is to be fed to calves in the best possible condition

Determine amount of milk to be fed A good rule to be followed in determining the amount of milk to be fed is that 1 pound of milk should be fed for each 10 pounds of live weight of the calf, with a maximum of 15 to 18 pounds daily This amount of milk may be too much at the start of feeding, for it is best to accustom the calf gradually to the amount it needs Use the figures given in Table 14 1 as a guide during the first 3 or 4 weeks

Table 14 1 Pounds of Whole Milk Fed to Calves Daily

	Age, weeks									
Breed	1	2	3	4	5	6	7	8	9	10
Ayrshire Brown Swiss Holstein	7	8	9	8	7	6	4	3		
Guernsey, Jersey	5	6	7	7	6	6	5	4	3	3

Feed the milk often In feeding the calf, it must be borne in mind that the digestive system of a young animal cannot assimilate a large amount of food at one time Plan to feed the calf three or four times daily during the first 7 days, at as nearly equal intervals as possible, as there is less danger of indigestion when the daily allowance of milk is fed in small quantities at short intervals than when fed only twice daily

Study economy of method Raising dairy calves largely or exclusively on whole milk is ordinarily the simplest method from the standpoints of (1) rapid gains in weight, for milk is the best feed for young calves, (2) comparative freedom from digestive disturbances, and (3) economy of labor The use of whole milk as the principal feed for the calf is usually too expensive a procedure in the case of calves being raised as herd replacements, for the value of the milk fed may exceed the worth of the calf at the close of the milk-feeding period

Feed whole milk to veal calves Dairy farmers located in areas in which the market prices of milk are low often find it advantageous to raise to veal age the male calves and also the heifer calves which are not considered suitable for herd replacements The economy of the operation is dependent upon the relative prices of milk and veal as well as the availability of labor

For both quality of veal and rapidity of gain produced, there is known at present no feed which is equal to whole milk. Gains are rapid and the quality of the carcass is better than when grain and hay comprise a large part of the feed.

Heifer calves of the larger breeds being raised as herd replacements normally gain from 1 to 1⅓ pounds per head daily during the first 2 to 3 months of age, while the gains for the smaller breeds are ⅔ to ¾ pound daily. In raising calves for veal, however, milk is fed more liberally and gains of 2 to 3 pounds per head daily are possible with the larger breeds. To obtain these rapid gains, feed the milk often and in as large amounts as the calves will consume. Place in the calf pen a hoop or other device for holding the milk pail so that the calf cannot tip over the pail. At each feeding, put in the pail a little more milk than the calf will immediately consume. A little later, the calf will drink more of the milk. Feeding in this manner encourages a large intake of milk.

A simpler plan of feeding calves for veal, of course, is to let the calves nurse the cows. This is sometimes done in dairy herds where there are one or more cows which for some reason, such as short teats, are difficult to milk. A high-producing cow ordinarily provides enough milk for the feeding of two to three veal calves at the same time. Since good veal weight ranges from 140 to 180 pounds, one high-yielding nurse cow is capable of raising a succession of calves to veal condition.

In feeding calves for veal, the usual rule for estimating the amount of milk required is that 10 pounds of milk produce 1 pound of gain in weight. Variations among calves in the amounts of milk needed occur because of differences in vigor, appetites, and daily rates of gain. The larger breeds are better suited than the small breeds for veal production because (1) the calves are much larger at birth and the original weight is marketed at the same price as the flesh gained as a result of feeding, (2) less milk and labor are required to bring the large calves to suitable veal weight, and (3) calves of the large breeds more nearly conform to the market requirements for veal and usually sell at a higher price per pound.

Substituting skim milk for whole milk. In some of the best purebred dairy herds it is the practice to feed whole milk to calves until they are 6 months or more of age. Whole milk, of course, is the best feed for calves, as it induces rapid gains and the calves that receive it keep in a healthy, sleek condition, being at the same time less subject to digestive troubles. In most dairy herds, however, this

method of raising calves is too expensive, and some other plan, such as the use of skim milk, is followed.

Secure supply of skim milk. If a cream separator forms part of the farm equipment, separate some milk at each milking and feed the skim milk fresh to the calves. Separate the milk as soon as possible after it is drawn from the cows, so that it will not be necessary to heat it. Should the milk become cold before being fed, heat it to about body temperature. In cold weather, warm the bowl of the separator by running 2 or 3 quarts of hot water through it before beginning to separate the cream.

When liquid skim milk is purchased, it should be thoroughly pasteurized in order to prevent the transmission of disease germs. In case it has not been pasteurized, it can be made safe for feeding by heating to the boiling point, or by holding at a temperature of 145° F. for 30 minutes.

Use dried skim milk when economical. Dried skim milk, known to the trade as nonfat dry milk solids, gives fully as good results as fresh skim milk and has the advantage of being free from disease organisms, thus requiring no pasteurization before feeding.

Consult the directions for feeding skim milk and prepare a daily feeding chart for each calf, setting down opposite each date the amount of skim milk to be given at each feeding. The same directions as to the amounts of skim milk to be fed apply to the dried milk after it has been prepared for feeding.

Calculate from the feeding charts that have been prepared the amount of the skim milk required for all the calves at each feeding. Weigh out one-tenth this amount of dried milk into a pail. If there are any lumps in the powder, rub them through a fine sieve. Add an equal weight of slightly warm water and stir the milk for a few minutes to dissolve as much of it as possible. Now pour into a milk can or other sufficiently large container, and add 8 times as much warm water by weight as the dried milk weighed out. This will bring the weight of the mixture up to 10 times the amount of the dried milk, which is similar to the concentration of separator skim milk. Stir the mixture thoroughly. The water should be warm enough to bring the final mixture to about body heat. Feed the skim milk prepared from the dried milk in the same manner and in the same amounts as ordinary separator skim milk.

Make substitution gradually. Begin substitution of skim milk for whole milk when calves are about 3 weeks old. Calves that are below normal in size or vigor should receive whole milk somewhat longer.

Make the substitution a gradual one For example, suppose 5 pounds of whole milk is being fed each calf at each feeding time The first day skim milk is used, mix 1 pound of skim milk with 4 pounds of whole milk at a feeding The second day use the same proportions The third and fourth days, use 2 pounds of skim milk to 3 pounds of whole milk, and so on until substitution is complete

The age at which skim-milk feeding should begin depends somewhat upon the amount of concentrates and hay being consumed More than 1 pound of concentrates is needed to replace the nutrient content of the butterfat of 10 pounds of whole milk, therefore, if the calves are not eating concentrates in liberal amounts, the beginning of skim-milk feeding must be delayed until they do eat them

Stanchion calves at feeding time If more than one calf is kept in a pen, provide individual stanchions and mangers Fasten calves in stanchions before feeding them milk, and keep them stanchioned until after they have been fed some concentrates This plan helps to prevent the calves from spilling the milk and also from sucking each other

Weigh milk for each calf Feed the calves individually from pails in order to ensure the proper intake of milk by each calf Feeding groups of young calves from troughs or small tanks is not satisfactory because of the likelihood that some calves will not receive enough milk and others may get too much Further, troughs are difficult to clean and are likely to be unsanitary

Weigh the skim milk for each calf at each feeding Follow a feeding chart, prepared in advance, which shows the amount to be fed to each calf In preparing the chart, use as a guide for the first 3 to 4 weeks the figures given in Table 14 1 After 4 weeks of age, gradually increase the amount of skim milk fed, being guided of course, by the amount of milk which the calf can safely handle, as well as by its cost and availability The rule mentioned for the feeding of whole milk, namely, 1 pound of milk daily for each 10 pounds live weight of the calf, is also a safe guide for the feeding of skim milk Fifteen to 18 pounds daily is ordinarily the maximum amount which should be fed

Weighing the skim milk is better than measuring it since the foam on skim milk may deceive the caretaker Foam usually is not injurious to calves but may prevent them from being fed enough milk if the quantities are measured rather than weighed

Continue skim-milk feeding as long as practical Continue to feed skim milk until the calves are 6 months of age or better still, 1 year

of age if possible In some cases, however the milk is too valuable to be used for feeding purposes except during the first 3 to 4 months when milk is essential in giving the calves a good start

Using calf starter method The expense and labor involved in raising calves when either liquid whole milk or skim milk is used have caused many dairy farmers to turn to the "calf starter" method The term calf starter applies to a mixture consisting of ground farm grains protein feeds, and minerals The mixture is sometimes reinforced with vitamins or antibiotics or both

In using the calf starter method whole milk is fed to 8 to 10 weeks of age, depending upon the vigor of the calf and its ability to consume freely adequate amounts of starter and hay The figures in Table 14 1 may be used as a guide for the feeding of whole milk Beginning at as early an age as the calf will eat it, supply starter in dry form in such amounts as the calf will clean up without waste From 2 to 5 pounds daily may be consumed and the feeding may be continued to 6 months of age Care should be taken to supply the calf with ample amounts of fresh drinking water (warmed in winter) and also high quality legume hay If difficulty is experienced from digestive troubles, feed only milk and hay a few days until the trouble clears up Gradually return to the regular schedule

Obtain good calf starters Calf starters may be purchased ready mixed or may be home mixed The formula for a calf starter which has proven satisfactory in the raising of a large number of calves is ground yellow corn, 20 pounds, crushed oats 25 pounds, linseed meal, 15 pounds, soybean meal, 6 pounds, wheat bran 2 pounds, alfalfa leaf meal 10 pounds, dried skim milk, 20 pounds, salt, 1 pound, ground limestone, 0 5 pound, steamed bone meal, 0 5 pound (total, 100 pounds) After the calves reach 3 months of age, the amount of skim milk in the mixture may be reduced gradually and the amounts of corn and oats increased to take its place until after 6 months of age no skim milk is included The presence of the dried skim milk helps to ensure steady gains in calves which are not strong and vigorous and good eaters

A simplified calf starter which has also given good results in tests (Illinois Agricultural Extension Service Circular D632) with calves of the five leading dairy breeds is made up as follows 50 pounds ground shelled yellow corn, 20 pounds ground oats, 27 5 pounds soybean meal (either expeller or solvent process), 1.5 pounds steamed bone meal 1 pound salt With either of the two formulas given above it is desirable to include in the mixture a dry vitamin A and D

concentrate at the rate of 4 ounces in 100 pounds of mixture whenever high-quality sun-cured hay is not being freely consumed.

Feed milk with starter. Continue to feed whole milk to calves receiving starter until they are at least 8 weeks old (large breeds) or 10 weeks old (smaller breeds). After 4 weeks of age the amount of whole milk may be tapered off (Table 14.1). The milk feeding is especially helpful in promoting growth. Some calves may not eat freely of starter and in such cases milk feeding may need to be continued for a longer time. When dried skim milk is included in the starter, whole-milk feeding may be discontinued somewhat earlier than otherwise.

When the feeding schedule for whole milk which is outlined in Table 14.1 is followed, the amount of milk fed is 364 pounds per calf. This amount is in addition to the colostrum milk which the calf is fed or obtains directly from its mother during the first one to two days. Numerous experiments have shown that about 350 pounds of milk is the minimum amount which can safely be used for the raising of a dairy calf.

Feeding buttermilk and whey. Undiluted buttermilk fresh from the churn is a good substitute for whole milk or for skim milk when fed to calves 6 to 8 weeks of age. It is similar to skim milk in composition except that it contains slightly more butterfat. Buttermilk may induce a laxative condition in young calves and for this reason care must be taken to substitute the buttermilk for the other milk gradually and also not to feed it to young calves. Dried buttermilk may be reconstituted to the fresh basis by mixing 1 pound of dried buttermilk with 9 pounds of warm water. Evaporated, or semi-solid, buttermilk requires the addition of 3 pounds of water to each pound of buttermilk. Prepared and fed in the manner described, fresh buttermilk and the reconstituted buttermilks have about the same feeding value for dairy calves as skim milk.

Whey is a by-product of cheesemaking. Practically all the fat and a large portion of the protein of whole milk go into cheese, leaving in the whey all the sugar (about 5 pounds in 100 pounds of whey) and about one-fourth of the protein (about 0.8 pound in 100 pounds of whey). Because of the low protein content of the whey, a grain mixture is needed that is much higher in protein content than a grain mixture suitable as a supplement to skim milk.

Both buttermilk and whey should be carefully pasteurized or sterilized at the factory, and care should be taken to keep them in clean vats free from decomposing material.

Keeping utensils clean While cleanliness is necessary in all feeding operations, it is especially important in the case of calves being fed milk because milk utensils are difficult to clean

Each day the cream separator, all pails cans or other utensils used for milk should be thoroughly washed with warm water and a detergent (not soap) They should then be scalded with boiling water and stored inverted so that they can drain

Feeding grain mixtures Encouraging the calf to eat grain at an early age is desirable Better growth and greater resistance to calf ailments result from consumption of both grain and milk than when only milk is fed, particularly in calf-raising programs in which limited milk feeding is employed

Provide suitable grain mixture Protein feeds such as blood meal and flaxseed meal are not the best supplements to milk, for milk is in itself a high-protein feed A suitable supplement to milk may be medium-high in protein when milk is fed freely The supplement should, however, be high in energy value Good grain mixtures for milk-fed calves are ones like the following ground corn, 2 parts, ground oats, 2 parts, wheat bran 2 parts, linseed meal, 1 part Another good mixture consists of ground corn 1 part ground oats, 5 parts, wheat bran, 3 parts, and linseed meal 1 part

Calves under 3 months of age usually prefer the ground feeds, but after 3 months of age whole grains may be fed

Begin feeding at early age Begin feeding grain mixtures as soon as the calves will eat them, which probably will be when they are 7 to 15 days of age It is usually necessary to coax the calves in the beginning in order to get them accustomed to the feed To do this place a small handful of the grain mixture used, or ground oats, or ground corn, in the pail as the calf is finishing its milk, or offer a little in the hand immediately after feeding milk

Provide large amounts of grain mixture so that the calves may grow rapidly This is especially important if skim milk is fed at an early age The grain mixture may be weighed or measured twice daily and placed in a box or manger to which the calf has access, or a constant supply may be kept before the calves

The amount of grain mixture consumed by calves under the usual plan of feeding is about 2 pounds per head per day when the calves are 2 to 3 months old, and 3 to 4 pounds when they are 6 months old

Feeding hay or other dry roughages The principal roughage fed to calves should be good legume hay, such as clover or alfalfa

Place some fine-stemmed, leafy legume hay, such as clover or alfalfa, in a rack so that the calves may have access to it from the time they are 10 to 14 days old Calves learn to eat roughage readily Replace the hay with a fresh supply every 2 or 3 days, or whenever the finer parts of the hay have been consumed The part refused by the calves may be fed to the older animals in the herd

Other roughages, such as non-legume hay and corn stover, are suitable only as supplements to legume hay and not as the only roughages fed, if good results are to be expected Such roughages may be fed in a separate rack, so that the calves have access to both legume and non-legume roughage at the same time In the case of calves several months old one feed of legume hay and one of non-legume roughage may be given daily

Feeding silage Certain precautions must be observed in feeding silage to calves If fed too early or too freely it may prove harmful When silage is available it may be fed to calves as soon as they will eat it, which is usually at 3 months or more Silage is not an especially desirable feed for calves, but may prove satisfactory in the absence of more suitable roughages such as good legume hay

Calves should be given only small amounts of silage Feed 2 to 3 pounds daily to calves 3 to 4 months of age, and increase these amounts about 1 pound per day for each month of the calf's age

Use every precaution to insure the quality of the silage fed Moldy or damaged silage may lead to indigestion

Feeding after discontinuing milk The period during which calves are most often neglected is soon after milk feeding is discontinued This is especially true if the calves are turned out to pasture and not given any regular daily feeding or attention to bring them under the observation of the caretaker

Examine the calves several times a week, noting their general thriftiness It is not necessary that they remain fat, but they should keep growing the hair should be sleek and the hides soft, and there should be no evidences of indigestion

Feed the calves liberally from the time milk feeding is discontinued Good legume hay and concentrates are among the best feeds, although good pasture is also desirable

Pasturing calves Provide a small paddock or separate pasture for calves if possible This is especially desirable in order to prevent injury by the older animals, to avoid nursing of cows in milk and to prevent the calves from exciting the cows by running about among them

Do not attempt to have calves less than 6 months of age secure much of their feed from pasture The annoyance of flies, exposure to the heat of the sun and excessive exercise are disadvantages of pasture which more than offset the value of the small amount of feed gathered

Make sure that the calves are receiving sufficient feed to keep them growing rapidly If the pasture alone is not adequate for this purpose feed some supplements, as indicated above

Give the calves access to a constant supply of fresh water and common salt If the pasture consists of non-legume grass growing on an acid soil, it is well to give the calves some mineral supplement, such as steamed bone meal of feeding grade Provide shade in hot weather

Insuring a supply of vitamins. As pointed out in Chapter 8 the vitamins to which most attention must be given in the feeding of dairy cattle are vitamins A and D Young calves fed only milk and not exposed to sunlight are likely to develop rickets Older calves are also subject to this malady during the winter months, especially if there is a deficiency of calcium and phosphorus in the ration Symptoms of rickets are swollen and stiff joints, an arched back, a craving for sticks and refuse, and a poor appetite Calves fed skim milk and bleached, stemmy roughages may not have an adequate intake of vitamin A

Calves at pasture in summer are protected against rickets by sunlight, but winter sunlight is so low in its antirachitic potency that protection from rickets during the winter months must come through proper feeding methods Green, leafy, new-crop hay cured in sunlight furnishes protection from rickets and also provides large amounts of vitamin A Calves should be encouraged at an early age to consume freely this kind of hay In the absence of hay of this sort, protection from rickets can be provided by the use of a dry vitamin A and D concentrate included in the grain mixture or calf starter at the rate of 4 ounces of concentrate to each 100 pounds of mixture or starter Alternate methods suited for young calves not eating freely of grain or starter are to feed daily in the milk a feed grade of liver oil at the rate of 1 teaspoonful for each 100 pounds live weight of the calf or to give vitamin A and D capsules especially prepared for calf feeding

As a rule, calves receiving good rations prepared and fed in accordance with the directions given in the preceding sections need be fed no vitamin supplements Such supplements may be beneficial,

however, when feeding methods, including the feeding of the mothers before calving and the feeding of the calves, are poor and the calves lack thrift

Providing minerals Milk is one of the best sources of calcium and phosphorus, the two minerals which dairy rations sometimes fail to supply in sufficient amounts As a rule, calves suffer no deficiencies in these minerals during the milk-feeding period High-quality legume hays are excellent sources of calcium, and phosphorus is supplied by grain mixtures or calf starters that contain 20 to 25 per cent dried skim milk or high-protein feeds

Unless these feeds are freely consumed after the milk-feeding period is past, supply a mineral mixture by including it in the grain mixture or starter at the rate of 2 per cent of the mixture, or offer it free choice in boxes to which the calves have access

Include salt in the starter or grain mixture at the rate of 1 pound in 100 pounds of the feed If located in a region where goiter (big neck) in calves has been noted, use iodized salt instead of ordinary salt

Older calves pastured on soils low in fertility or fed roughages from such soils may suffer from deficiencies of other minerals This subject is appropriately treated under the raising of the dairy heifer

Supplying antibiotics In the feeding of some species of farm animals, particularly young pigs and chicks, the use of antibiotic substances, such as aureomycin and terramycin, have proven beneficial in promoting rapid growth Although several trials in which antibiotics were fed to dairy calves have been conducted, the evidence is not entirely clear as to whether the results were superior to those obtained through the liberal feeding of milk At present writing, therefore, the use of antibiotics in the routine feeding of calves cannot be recommended as an advantageous procedure Such compounds may be useful in treating cases of illness, however

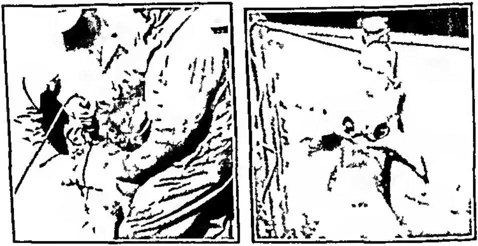
Preventing growth of horns The practice of dehorning cows in order to prevent them from injuring one another is considered humane A fight between horned cows frequently results in severe injury and sometimes in death It is much easier, and causes less suffering to prevent the growth of the horns than to remove them after they are full grown Dehorning is not ordinarily practiced in show herds, since well-shaped and polished horns are considered an additional point of merit in the show ring

The horns begin to form little prominences, or buttons, on the head when the calf is but a few days old When these can be plainly felt,

which occurs when the calf is about a week old they should be treated to prevent further growth of the horns

Clip the hair closely around each of the horns, exposing a clean surface of the skin Use sharp scissors for this purpose

Apply some Vaseline or other salve to the skin around the horn but do not apply it to the skin covering the tip of the horn The purpose of the Vaseline is to prevent the caustic from spreading and injuring the skin



(a) (b)

FIG 142 Calves may be dehorned by means of an electric dehorner (a) The instrument is applied to the horn buttons for 10 to 15 seconds (b) The scars heal in a few weeks and are replaced by hair (Courtesy Sunbeam Corporation)

For this purpose use a stick of caustic which can be obtained at a drug store Keep all except the tip of the stick carefully wrapped in paper to protect the hands Have someone help hold the calf still Moisten the tip of the stick of caustic slightly in water and rub firmly on the skin covering the tip of the horn Rub until the skin becomes red and is about to bleed Be careful not to get so much water on the caustic that it runs down on other parts of the skin or into the eyes of the calf

If the treatment is effective, a deep scab will form in two or three days This will slowly heal, and in the course of a few weeks the scab will drop off and hair will return If the first treatment is not effective repeat after the fourth or fifth day, rubbing a little more vigorously

An alternate method where electric current is available, is to use an electric dehorning device The horn buttons are exposed in the same manner as described above, but instead of using the caustic, an electric dehorning iron is applied to the horn button for about 10 seconds A dry scab will form over the seared area, and after a period of several weeks both the scab and horn button will drop off Do not attempt to remove the scab but allow it to mature and fall off of its own accord When using the electric method, much care must be exercised to avoid severe burns

Marking calves for identification Some reliable system of marking animals for identification should be employed in every herd

Before the calf is separated from its mother, that is, within a day or two after birth, place a strap or chain bearing a numbered tag about the calf's neck Enter the number, together with date of birth, weight, etc , in your record book If the calf is other than a solid color, sketch the outlines of the color markings in the place provided in your herd book, and enter there, also, the appropriate data The sketching should be done within a week or two after birth

Neck straps or chains with numbered tags are satisfactory until the calf is a year old, but there is always danger that they may become broken or lost A more permanent system of markings, such as one of those described in Chapter 11, should be adopted, and all calves should be marked according to that system before they are more than 1 year of age

Providing bedding for calves Provide ample amounts of bedding to keep calves dry When calves lie on wet bedding in cold weather, they are likely to become chilled and to contract severe colds or pneumonia

Clean, dry materials such as straw, ground corncobs, and shredded corn stover, make excellent bedding for young calves Shavings and sawdust are not good for bedding calves which receive milk only, since such calves may eat some of the bedding Fatal results may result from the eating of shavings or sawdust

Experiments carried out at the New Jersey Agricultural Experiment Station showed that the use of wire floors in calf pens resulted in a saving of two thirds to three-fourths of the amount of bedding required The wire cloth used had a three-fourths inch mesh and was made from No 11 wire, galvanized after weaving The cloth was placed over wooden frames on which No 9 wire had been stretched to support the wire cloth A space of 6 inches between the frame and the cement floor of the pen permitted cleaning The bedding placed

over the wire cloth remained much drier than when used on a cement floor and it was thought that the calves remained freer from colds, scours and pneumonia, and also made better gains than when housed in the usual manner

Preventing calf ailments Dairy calves are beset with a number of ailments, most of which can be prevented wholly or in part by good methods of management

Common scours This ailment is indicated by a loose or liquid discharge from the bowels, loss of appetite and gaunt appearance of the body Common causes are too large amounts of milk, irregularity in amounts or temperature of milk or time of feeding, feeding milk too rich in fat, feeding dirty or sour milk, and the use of dirty pails

First, correct the conditions leading to the difficulty, then reduce the amount of milk fed to one half the usual amount In mild cases, scalding the milk and then cooling to body temperature before feeding may correct the trouble In severe cases, give a physic of 1 to 2 ounces of castor oil (depending on size of calf) in a pint of milk, and give in the milk, or place on the tongue two or three times daily, 1 teaspoonful of a powder consisting of 1 part salol and 2 parts subnitrate of bismuth In addition give 1 teaspoonful of liver oil or a calf vitamin capsule (containing vitamins A and D) daily until recovery is complete

White scours The symptoms of white scours, a highly infectious diarrhea, are frequent discharge of nearly liquid dung which is dirty white in color and has a foul odor, within a few hours the calf becomes too weak to stand and it may die in 2 to 4 days The disease is nearly always fatal

The infection is carried from one calf to another on bedding pens, mangers, and stalls with which infected calves have been in contact If cases have occurred in the herd previously, carefully clean and disinfect thoroughly the quarters in which calves are born and the mangers, stalls, floors, and walls of the pens in which they are raised Burn or bury the bodies of all calves that die of the disease, and burn all the litter in the stalls

See that the calf has some of its mother's colostrum milk Wash the udder and teats with a disinfectant solution before permitting the calf to nurse Treat the navel of the calf with 30 per cent tincture of iodine

Some of the recently developed sulpha drugs and other treatments, including antibiotics, have been useful in some cases Such treat-

ments, however, should be used only after obtaining competent medical advice

Pneumonia This disease frequently occurs in calves It is indicated by difficult breathing and frequent coughing Occasionally the disease is so severe in character that the calf dies within a few days without exhibiting typical symptoms In less severe cases, there is dullness, poor appetite, a rough coat, rapid loss of flesh, and above normal temperature

Preventive measures consist in establishing such good feeding practices in the herd that cows before calving have a high intake of carotene, thus ensuring a high vitamin reserve in the calf at birth and in the colostrum milk Prevent the chilling of calves and exposure to cold drafts Provide ample amounts of dry bedding

Isolate all sick animals and obtain competent medical advice Careful nursing and good care often result in the saving of a goodly proportion of affected calves provided treatment is begun in time Feed whole milk and vitamin supplements until recovery is complete

Lice Calves are subject to infestation by lice, particularly if closely housed in groups The calves become unthrifty and listless There is itching of the skin and the hair falls out because of rubbing The control measures recommended for the herd as given in Chapter 11 may also be used for calves

Lack of cud inoculation Under normal conditions forage-consuming animals take into their digestive tracts enormous numbers of bacteria and other microorganisms which are present on the forage These organisms play a necessary and valuable role in the digestive process, aiding in the digestion of cellulose (fiber) and converting it to soluble nutritive compounds which can be assimilated from the digestive tract Among the best sources of these minute organisms are well cured green hay and silage, and also pasture forage

Young calves receive these organisms in large numbers and become inoculated with them as soon as they begin to eat good quality hay or other forage Such feeds as mow-burned hay or decaying or moldy silage may not be good sources Occasionally calves lack proper inoculation with these valuable organisms because of one or more of several conditions, such as (1) poor appetites resulting from illnesses such as scours and pneumonia, (2) medical treatment with sulpha drugs or other medicines including antibiotics which may destroy the microorganisms throughout the digestive tract, and (3) high fevers that accompany pneumonia and some other illnesses which also may destroy most of the organisms

When a calf lacks thrift, has poor appetite, and has no detectable illness, try the cud inoculation procedure by transferring from a cow one or more cuds daily for a week. While a quiet cow is "chewing her cud," watch until she places a cud in her cheek for chewing. With the left arm over her head, grasp her upper lip with the fingers of the left hand Using the right hand, reach into her mouth and remove the cud Place the cud on the back of the tongue of the calf, and see that it is swallowed. A number of cuds daily may be needed for large calves.

The cuds contain millions of bacteria and serve to inoculate the digestive tract of the calf so that it functions normally in the digestion of roughages Commercial preparations supplying the same kinds of bacteria have been placed on the market Experimental tests have shown that some calves are greatly benefited by cud inoculation. This treatment, however, may have little value as a preventive of scours

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REVIEW

1 Why is the raising of dairy calves an important feature of dairy farm operations?

2 List the essential qualities of a good ration for dairy calves

3 Outline good methods for the care of the calf at birth, listing necessary procedures

4 How may a calf be taught to drink? Mention precautions which should be taken

5 Describe good methods for the feeding of whole milk, including amounts to be fed, frequency of feeding, and feeding to veal calves

6 Discuss the feeding of (1) liquid skim milk, (2) dried skim milk, to dairy calves

7 What is a calf starter? How is it fed? How formulated?

8 Why is it important that feeding utensils be kept clean and how may cleanliness be provided?

9 Discuss the feeding of (1) grain mixtures, (2) hay, and (3) silage, to dairy calves

10 What precautions should be taken after milk feeding is discontinued and in the pasturing of calves?

11 Discuss the feeding of vitamins, minerals and antibiotics to dairy calves

12 Outline preventive and control measures for calf ailments, including common scours, white scours, pneumonia, and lice, and lack of cud inoculation

15

Raising Dairy Heifers

The great need for selecting only the best animals when choosing young stock to be raised as herd replacements and as herd sires becomes more and more evident when a study is made of three sources of information which have a direct bearing on this matter The average butterfat yield per cow in herds enrolled in dairy herd improvement association work has shown a steady increase over a period of many years (Table 12 1) This is likewise true for the average production of milk cows in the country as a whole (Table 1 2) In studying the ability of sires proven in dairy herd improvement association work to transmit high production to their daughters, it is clear that, in a high proportion of cases, the daughters of these sires produced less or no more milk than did their dams (Table 15 1) Further, as the level of production became higher, a smaller and smaller proportion of the sires had daughters which exceeded

Table 15 1 *Influence of Sires on Production of Their Daughters* *

Butterfat Production Range of Dams, lb	Sires Included in Study		Dam-and-Daughter Pairs, number	Production			
				Dams		Daughters	
	Total Number	Effective % †		Milk, lb	Butterfat, lb	Milk, lb	Butterfat, lb
250–274	46	70	346	6,597	264	7,061	292
300–324	215	78	1,595	7,500	314	8,100	347
350–374	644	64	5,408	8,655	363	8,915	380
400–424	820	57	7,273	9,977	412	9,990	418
450–475	514	45	4,402	11,312	462	11,017	457
500–524	212	45	1,733	12,664	511	12,045	490
550–574	45	40	321	14,023	560	13,306	539

* Summary of Proved-Sire Records Compiled in 1953 D H I A Letter, *30*, No 4 U.S D A, 1954

† Proportion of sires that maintained or increased production of daughters as compared with production of their dams

their dams in butterfat production. Thus, it is readily apparent that an increasingly careful job of selection must be carried out if the production per cow in dairy herds is to continue to have an upward trend.

Keeping proper objective in mind. Large, growthy heifers capable of beginning their milk-producing functions at an early age are desired. Not only do large heifers bring higher prices when offered for sale than do small heifers, but the large ones have the advantage that they are better able to calve at a young age. Early calving means an early return on the large investment in feed and labor spent on raising the animals. Then, too, large size has been shown to be a distinct advantage in making possible a larger yield of butterfat per cow than is obtained from small cows of the same breed. These increases have been found to range from 14 to 22 pounds of butterfat yearly for each 100 pounds increment in live weight. High yields per cow have a profound effect upon the efficiency of milk production and the monetary returns therefrom (Table 19.5).

While dairy cows continue to grow until they are 4 to 5 years of age, those that are undersized at their first calving may not reach normal size unless they are given extra feed for growth in addition to that required for milk production, for the production of milk tends to check the rate of growth in cows skimpily fed. Good feeding practices, therefore, prescribe that heifers should be at least of average size, and preferably above average size, by the time they are ready to produce milk.

Give good care after milk period. Suitable procedures for providing good feed and care for the calf up to 6 months of age have been outlined in the preceding chapter. After the milk-feeding period is past, there is a tendency to neglect young stock since they are usually fed in groups rather than as individuals. It is frequently assumed, for example, that when the young stock are turned to pasture, or are self-fed from hay racks and feed bunks, they are adequately cared for and require no further individual attention This is often a mistake, for some animals which are not good grazers or good roughage eaters may fail to obtain sufficient feed to make normal growth. Continue to give the young animals individual attention. If some animals are in need of additional feed, separate them from the main group and supply the supplementary feed required.

Feeding and caring for heifers in winter. In northern sections of the country, it is a decided mistake to attempt to make growing dairy heifers "rough it" during the winter. Do not expect them to obtain

their principal feeds during the winter months from stalk fields or straw stacks Protect the heifers from severe weather by housing them in a comfortable, well-ventilated barn or in a well-bedded shed partly open on one side Even in sections of the country where winter weather is mild, provide protection from cold rains and storms

Feed liberally in winter Good feeding practice for dairy heifers differs in principle but little from that of feeding cows for milk pro-

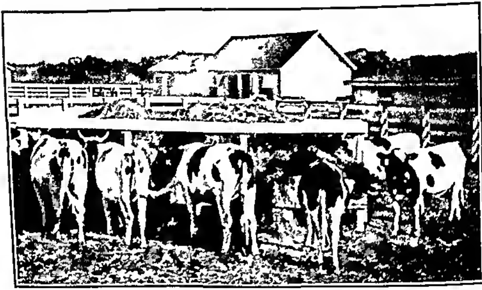

FIG 151 During the milder parts of the winter and in mild climates hay is advantageously fed in outdoor racks

duction The qualities of a good ration for milk cows, as outlined in Chapter 8, apply equally well to the feeding of dairy heifers In the feeding of high producing cows, however a fairly high proportion of the total digestible nutrients of the ration must be furnished in the form of grain mixtures Dairy heifers, on the other hand, require feed only for maintenance and growth, and this means that in most cases roughage feeding can be relied upon to furnish a fairly high proportion of the nutrients, provided the roughage is of good quality

When the supply permits, feed the heifers largely on legume hay, with some grain mixture in addition Non-legume hay, corn stover, and other non legume forages may be fed freely, but should be supplemented, if possible, by one feed daily of legume hay Provide all the roughage the heifers will consume, in order to develop their digestive capacity and to take advantage of the usual lower cost of total digestible nutrients in roughage than in grain mixtures

Feed silage, if available to the extent of about 2 pounds daily per 100 pounds live weight. No harm will result, however, from feeding as much as the heifers will eat. In some cases, heifers are fed no roughage other than silage. This is a fairly common practice when the silage is made from legumes or a grass-legume mixture. Heifers consuming large amounts of silage seem to crave some dry roughage and it is, therefore, desirable to supply some dry hay when silage is fed.

Feed grain mixture in addition to roughage when needed in order to keep heifers growing rapidly. Heifers being fed at will on high-quality legume roughage may require no grain mixture as a supplement. On the other hand, roughage of poor to fair quality is usually eaten in smaller quantities and, therefore, should be accompanied by grain feeding. Usually the feeding of 3 to 5 pounds of grain mixture per head daily is ample.

The guides for the formulation of grain mixtures as given in Chapter 8 may be used in preparing such mixtures for dairy heifers. These guides point out that the character of a suitable grain mixture is dependent upon the kind and quality of the roughage being fed. Hence, a plan which simplifies the work program and at the same time produces good results is to feed the heifers from the same lot of grain mixture as that fed the cows, provided, of course, that both groups receive the same kind of roughage.

At all times the judgment of the feeder must be exercised in deciding upon the amounts of grain mixture to be fed. No hard and fast rules can be laid down. The quality of the roughage, the warmth of the quarters, the amount of outdoor exposure, and the climate, all play a part in affecting the amounts of feeds needed. The condition of the heifers is also a factor. As a rule, heifers should not become fat until shortly before calving. Rapid growth should be promoted by liberal feeding of good-quality roughage, adding only enough grain mixture to ensure rapid growth. Two or three months before calving, begin liberal feeding on grain mixture in order to have the heifers in an excellent state of flesh before calving. This helps to ensure high milk yields following parturition.

Feeding and caring for heifers at pasture. *If young stock are* changed abruptly from a milk and grain ration to pasture feeding, they usually consume but little feed for a time and may lose weight rapidly. Calves under 6 months of age are seldom well enough developed to make good use of pasture. It is a good plan, there-

fore, to make sure that young stock are accustomed to eating roughage before they are turned out to pasture.

Provide good pasture, if possible. Good pasture is usually the most economical and also the best source of feed supply for growing heifers It furnishes the necessary growth factors (vitamins, minerals), which may be insufficient in quantity in winter rations.

Legume pastures, or legume-grass pastures, of course, are generally superior to all-grass pastures unless the grass pastures are grown on

FIG 152. Getting heifers out on luxurious green pasture early in the spring helps to supply them with ample amounts of vitamins, sunshine, and exercise.

highly productive soils or are well fertilized. If the pastures are not productive, study the possibility of introducing an improved pasture system, as outlined in Chapter 24.

Supply supplements to pasture when necessary. For the first week after turning to pasture, keep a supply of dry hay or straw in a rack to which the heifers have free access. This helps to make the change a more gradual one and is also an aid in preventing bloat. As early spring pasture forage is high in water content, a pound of fresh forage at that season provides relatively little nourishment. Hence it is best to continue the feeding of grain mixture in small amounts to young heifers for 2 to 3 weeks after they are first turned on spring pasture.

During late spring and early summer good pasture alone usually provides plenty of feed for growing heifers; but as soon as the forage

becomes dry and the pastures somewhat bare, additional feed is needed. Yearling heifers may be fed the same kind of supplements, consisting of hay, silage, or grain mixtures, that are being used for the cows in milk (Chapter 9). Heifers less than a year of age, however, cannot be expected to consume enough hay or silage to meet their requirements when pasture furnishes but little forage. For such heifers, provide a grain mixture, fed at the rate of ¼ to ½ pound daily per 100 pounds live weight and, in addition, 2 to 4 pounds of legume hay.

FIG 15.3 Supplementing scanty pastures by placing hay in racks in the pasture is an excellent way of promoting normal gains It also is an aid in preventing *bloat*

There is a tendency to keep young stock at pasture late in the fall in order to keep the labor load at a low level. At this season the pasture forage may be scanty or low in nutritive value because of a high proportion of weeds Lack of attention to the needs of the animals at this time may lead to a loss of live weight, particularly if the weather is cold and damp.

Furnish water, minerals, and shade. Give the heifers constant access to a supply of fresh, clean water. Permit them to have all the common salt they desire; and if the pasture is located on a soil low in productivity or consists of grasses only, give them access to mineral supplements, as recommended for dairy cows (Chapter 8).

Prolonged exposure to hot sun may be harmful. Permit night grazing and access to shade during the middle of the day.

Studying the factors affecting growth of dairy heifers. Various factors have an influence upon the size attained by the dairy cow

at maturity. Although heredity plays an important part, most of these factors can be controlled by feeding and management.

Breed. The limits of the size of the calf at birth and the size of the mature individual are largely determined by characteristics inherited from the parents, and these are peculiar to the breed to which the animal belongs. Thus, the average Holstein female is larger at birth than the average Jersey female and, as a rule, attains a larger size at maturity. No known plan of feeding will cause the Jersey calf to develop into as large an animal as the Holstein. There are within the breeds, however, certain families or strains which are larger and more rugged than others, and this characteristic is transmitted to the offspring.

The Jersey heifer reaches her full size of skeleton at about 4 years of age, while the Holstein continues to grow until she is nearly 5 years old. The Jersey female attains her maximum weight at about 6 years of age, while the Holstein reaches this stage when 6 or 7 years old.

Size of calf at birth. There seems to be little, if any, direct relation between the size at birth and the size at maturity of calves of the same breed, provided they are given a good opportunity to develop.

Pregnancy. Careful records of the rate of growth of heifers during the time they are carrying calves indicate that pregnancy has no material effect upon their rate of growth Some feed in addition to that required for growth, however, must be supplied during the last three months of gestation for the development of the fetus.

Lactation. After a good dairy cow gives birth to a calf, she possesses a strong stimulus to produce milk. The nutrients received in her feed are directed toward the production of milk so far as possible, and often if they are not sufficient she draws upon her own body tissues. Naturally, under such conditions, growth is seriously retarded. It is only when young cows are liberally fed and given rest, or dry periods of suitable length, that they can continue to grow normally after they have begun to produce milk.

Feed supply. It has been pointed out that the possibilities for growth in an animal are largely determined by the size of the breed. Whether an animal is small, average, or large in size for the breed depends mainly upon the character and amount of the feed supply. With liberal programs of feeding, it is often possible to raise animals which are much above the average for the breed.

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REVIEW

1 Cite figures or mention evidence which shows that the selection of dairy heifers which are to serve as herd replacements require more care and study than formerly

2 Discuss the objectives which should be kept in mind in the raising of dairy heifers

3 Outline a good program of feeding dairy heifers during the winter

4 At what age are dairy heifers able to make good use of pasture?

5 Mention the precautions which should be taken when heifers are first turned to pasture

6 What kinds of supplements to pasture are suitable for dairy heifers and in what amounts should they be fed?

7 Discuss each of the principal factors which affect the rate of growth of dairy heifers

16

Preventing Illness in the Dairy Herd

In most business enterprises there are numerous risks which must be taken Among the risks which confront a dairy farmer at all times is the possibility of economic loss through the inroads of infectious diseases, minor ailments, and accidents which may affect his dairy herd Occasionally disease may enter the herd through no fault of the farm operator or herdsman, while in other cases ailments may inflict the herd as a result of careless or poor management

The herd owner who is well informed concerning the principles of disease prevention can do much to prevent illness from entering the herd and he can also, through effective measures of herd sanitation do much to reduce or eradicate a disease or ailment once it has appeared in the herd In most instances however the owner should not attempt to treat diseases of unknown cause or diseases requiring technical skill unless this is done under direction of a trained veterinarian

The discussion presented in the following sections is intended as a guide to the principles of disease prevention rather than as an outline of methods of disease treatment

Keeping premises in sanitary condition In the care of dairy cattle, as in other lines of work, it is generally recognized that prevention is better than cure Seven important procedures in providing sanitation are given below

Keep barn and lots clean Remove manure and litter from the stable regularly In stanchion barns this is best done once or twice daily depending upon available facilities If removed only once daily, adjust the bedding frequently so that cows are kept clean When special milking rooms, or parlors, are used, wash or scrape the manure into the gutter frequently, and at the clo e of the milking period give the room a thorough cleaning

When cows are stabled in pen barns, remove the manure whenever necessary to prevent mudholes or as often as directed by the milk

inspector In northern regions, clean the pen barn at least once a year After cleaning cover the floor with a heavy coating of hydrated lime to prevent the breeding of flies Some city boards of health have regulations which specify that loafing barns shall not be used during the summer

Scrape or sweep the walls and ceilings of all pens and stables once or twice a year and follow with a heavy coat of whitewash or paint In some cases, more frequent cleaning than this may be needed

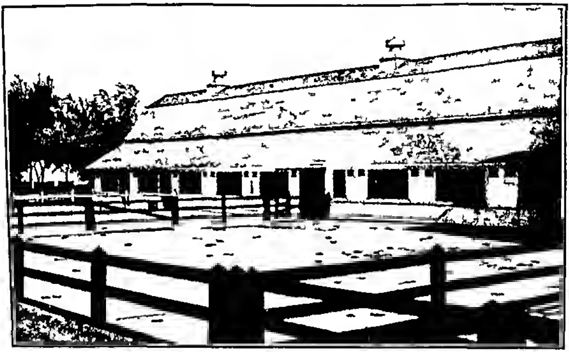

FIG 161 Keeping the yards and exercising lots clean and free from litter is a first requisite in keeping the herd healthy A paved barnyard aids in doing this This barn is fitted with glass-block windows

Keep all lots about the barns well graded so that water drains off quickly Scrape the surface of the lots that are not in grass several times a year to remove manure accumulated on the surface, and haul the manure to the fields

The paving of exercise lots with concrete asphalt or other hard durable surface is a distinct aid in the sanitation program It also makes possible the saving of much manure which otherwise would be wasted Muddy lots contribute to such diseases as footrot and mastitis and also tend to increase the bacterial count of the milk

Provide good feed and clean water So far as possible, avoid feeds which are moldy, musty, or contain foreign matter such as harmful weeds and rodent droppings Newly made silage and newly har-

vested hay undergo fermentation for 2 to 8 weeks Use caution in feeding them for they may cause bloat or other digestive disturbances

Provide clean drinking water and frequently scrub out all watering tanks and bowls A few ounces of copper sulphate may be placed in large stock watering tanks to retard the growth of algae and other water plants In most cases stagnant ponds in which cattle wade

Fig 162 Frequent cleaning of the feed alleys is a good precaution against contamination of the feed by the feet of visitors or of the caretaker (Agricultural Photo Library)

cannot be regarded as clean or desirable sources of water for dairy cattle

Protect herd from neighborhood infections When cases of infectious disease such as brucellosis are known to have occurred on neighboring farms special precautions are needed If pastures receive drainage water from farms in the neighborhood relocate these pastures if possible in order to avoid this drainage If the pastures adjoin those of another farm construct a temporary fence 12 to 15 feet inside the line fence to prevent the possibility of direct contact of the animals

Keep feed alleys of barn well swept, and as far as possible prevent visitors who come from neighboring farms from walking over feed. Keep poultry, birds, dogs, and cats out of hay mows, silos, feed bins, and mangers. Use a rodent exterminator which is non-poisonous to humans and cattle to destroy rats and mice.

Dispose of dead animals promptly. Dead animals must be disposed of promptly in order to prevent the spread of infection to the farm family or to other animals. Use great care in the handling of dead animals, particularly when the cause of death is unknown. In some cases disposition may be easily effected by requesting a rendering works to pick up the body. In case the dead animal must be disposed of by the herdsman, the body should be removed to a safe distance from the farm buildings and from all fields to which the cattle have access. Burn the carcass or bury it 5 or 6 feet deep. When animals die at pasture, it is best not to move the body to another location, but to bury it at the place where it died. If it is to be burned, lay sticks of wood on the ground and by means of poles, tip the body over the wood. Lay a sufficient amount of wood about the body to burn it completely, and burn the poles used in moving the body. If the body is buried, sprinkle fresh mason's lime on the surface of the ground where the animal lay.

The practice of removing the hide from dead animals is not a safe one unless it is known with certainty that the cause of death was not an infectious disease which might be contracted by a person handling the carcass. Burying animals at a shallow depth in lots or pastures may cause the spread of disease.

Disinfect barn after disease has occurred. One of the important steps in preventing further outbreaks of disease is careful and thorough disinfection of all of the stalls, pens, or other parts of the premises with which diseased animals have had contact.

When a single animal is attacked by an infectious disease, such as white scours or brucellosis, remove the animal at once to a separate barn or shed where it will not come into contact with the rest of the herd. Then disinfect the barn or parts of the barn where the animal has been. When several animals in the herd have been infected, it is often best to disinfect the whole barn after they have been removed.

FIRST CLEAN THE BARN THOROUGHLY. Remove all feed, manure, and litter. Scrape the stalls, walls, floors, and cupboards, so that the wood or masonry shows a clean surface. Use sharp-edged tools, such as shovels, spades, and special scrapers for flat surfaces and

wire brushes for both flat and rounded surfaces Burn or bury the material removed

Employ a suitable disinfectant One of the most economical and yet most effective disinfectants is lye, that is the common lye used for household purposes, usually sold in 12-ounce or 16-ounce cans Used at the rate of one can of lye to 5 gallons of either hot or cold water this disinfectant has been found effective for use in stables, provided the surfaces are clean and the lye is used liberally A number of other disinfectants suitable for stable disinfection are also on the market Those which leave strong odors usually are not suitable for use in milk houses or milking parlors Most disinfectants are powerful poisons and great care must be exercised in their use In most cases disinfectants requiring the use of water are best used when weather conditions permit rapid drying

Apply the disinfectant by means of a spray pump Soak the walls, floors, and mangers thoroughly Use a stiff broom or wire brush to work the disinfectant into woodwork or masonry which has rough surfaces After the job of disinfection has been completed rinse out the mangers with clean water

Dirt floors cannot be completely disinfected If dirt floors are used in stables or loose-housing barns in which cattle have reacted to tests for tuberculosis or brucellosis or have died from some other serious infectious disease, a temporary measure of protection during the winter is removing all manure and litter, scraping the walls, posts, and mangers, and then covering the floors with a layer of quicklime to a depth of ½ to 1 inch As soon as the soil is workable, the dirt floors should be removed to a depth of 4 to 5 inches, the adjoining walls cleaned and disinfected, and then a new floor installed The new floor preferably should be of cement construction, but if this is not possible, replace it with clay obtained from a location not contaminated by livestock

Isolate new animals brought into the herd Keep purchased animals in a separate barn or shed for 30 days, and preferably 60 days and observe them for symptoms of infectious diseases before adding them to the herd As pointed out in the discussion of brucellosis it may be best to retest the animals for this disease during the isolation period

Spray barns and sheds with insecticides Flies interfere with the grazing of cattle, annoy cows during the milking hour, and carry bacteria into milk if they get into pails or other milk containers As soon as the fly season begins, spray all quarters where cattle are

kept with an insecticide which kills flies and other insects Note directions given in Chapter 11

Preventing illness through good management Careless methods of management often lead to the spread of infections and many accidents The caretaker who is alert in giving his animals the best of care at all times is usually well repaid for his efforts

Satisfy nutritional needs Good management from the nutritional standpoint consists in ensuring an adequate intake of nutrients the year round, as was pointed out in Chapters 8 and 9 When the principles outlined in these chapters are carefully adhered to, there is ordinarily no need to further supplement the ration with mineral, vitamin, or hormone preparations Dairy farmers are frequently persuaded to purchase such supplements whenever it is observed that milk yields are declining at a faster than normal rate In remedying such a condition, first check carefully on the character and amount of the roughage and grain mixture being consumed by individual animals Often it may be found that the pasture is inadequate or the quality of the wintertime roughage is so poor that cows do not eat enough to satisfy their needs Perhaps some cows are not being fed enough grain mixture The grain mixture may not contain enough protein concentrate to properly supplement the roughage Before investing in special preparations, remedy any shortages in feed intake and watch for improvement in milk yield In nearly all cases, any shortage of nutrients may be supplied by good rations When dairy cows need nutritive material or hormones other than those supplied in good rations, it is best to consult a trained veterinarian

It is commonly assumed that breeding difficulties in the dairy herd can be corrected by additions of vitamin or mineral preparations to the ration Among the materials sometimes used for this purpose are vitamin E, ascorbic acid, and "shotgun" mixtures containing many mineral elements Occasionally the feeding of these materials to the dairy herd has seemed to prove efficacious, but usually their use has been accompanied by improved feeding and care Hence it is often difficult to determine whether the benefits observed were traceable to the better feeding program or to the special supplements Carefully conducted trials at state agricultural experiment stations have not yet shown that the use of such special supplements is beneficial or justified when dairy cattle receive good rations made up from high-quality feeds The first procedure in remedying a supposed nutritive deficiency, therefore, is to make sure that adequate rations are being supplied in accordance with the individual needs of each

animal One of the dairy farmer's most popular remedies for delayed breeding is the turning of the dairy herd onto fresh, green pastures in spring Breeding research indicates that this practice has much to commend it

Protect animals from extreme weather Dairy cattle in the northern states must be protected from extreme cold, extreme heat, and also from cold rains and snow storms Although dairy cows may be kept under a loose-housing plan suitable protection from cold and storms must be provided (See Chapter 27) In the southern and southwestern states, protection from extreme heat is usually a more serious problem than protection from cold Provide protection from the sun by means of shade trees lightly constructed sheds open on all sides, or by keeping the milking herd in the stable during the hottest hours of the day If conditions warrant it, install fans or other means of circulating the air in the stable to aid in keeping the cows cool Make sure that cows have ready access to water at all times or at frequent intervals

Avoid harmful materials Good housekeeping is a term which fits into efficient management of the dairy herd Carelessness leads to many ills and accidents

Cattle frequently swallow nails, pieces of baling wire, staples, stones, cinders, and bits of wood which may be mixed with the feed Sharp objects such as nails and wire frequently lodge in the reticulum, the second compartment of the stomach, which is located close to the heart Fatalities often result from punctures of the reticulum and heart

Injuries to cattle may result from contact with sharp bladed or sharp-pointed implements, such as disks, harrows, and harvesters, which are left in exercising lots, lanes, or pastures

Compounds used for the treatment of seed grains are in most cases slightly or heavily toxic to cattle Hence it is best not to feed any grains to which seed treatments have been applied DDT, an insecticide used in the dusting of corn fields for the control of corn borer, may be present on the forage if applied shortly before harvest As a rule, allow 60 days to elapse between dusting and harvest Heavy rains remove much of the poison from the forage If DDT is present on forage consumed by cows some of it may be transferred to the milk When milk containing traces of this compound is consumed regularly, harm may result

Avoid the use of lead paints in dairy barns, pens, and on fences wherever cattle can reach the painted surfaces Cattle gnaw or

lick painted walls and fences. They also lick zinc-coated metal containers, thus removing some of the coating which contains lead as well as zinc. Lead is toxic to both cattle and man. Taken in small amounts, it may cause serious illness, and in large amounts it causes fatal results. Paints which do not contain lead have been developed especially for use in locations where lead is objectionable.

Sudden declines in milk yields and sometimes complete cessation of milk flow occurs in the fall when cows on scanty pastures in search of additional feed eat acorns, hedgeapples, and persimmons. Some weeds have toxic effects Among the latter are nightshade, jimson weed, cocklebur, dwarf larkspur, white snakeroot, and water hemlock. Cattle may also eat the leaves of poisonous trees such as black locust, wild cherry, and buckeye.

Rendering first aid to sick animals. In many cases, serious illness may be avoided by rendering first aid treatment. Whenever special skills are required or the cause of disease is unknown, obtain the services of a trained veterinarian.

Isolate the animal. As soon as illness is observed, remove the animal to quarters, preferably a box stall, where it will not come in contact with other animals.

Observe animal closely. Keep a sick animal under close observation and note all the symptoms in order that you may determine, if possible, the cause of the illness Often the first sign of sickness is the failure of the animal to eat any or all of its feed. The animal may move sluggishly or, less often, may be excited and quick in its movements.

When an animal is in intense pain, it often stands or lies quietly in a drooping position with eyes sunken. Take the temperature of the animal by inserting a clinical thermometer into the rectum and leaving it there for 3 minutes. If the temperature is much above or below normal (101° to 102° F.), it is usually best to call a trained veterinarian If the temperature is about normal and the animal does not seem to be in pain, apply the general preventive measures outlined below. If the illness becomes worse, secure competent advice.

Reduce feed supply. As soon as illness is noted, reduce the amount of feed offered. Give no concentrates and only half the usual amount of silage, together with a moderate amount of good-quality legume hay. Some fresh green grass is also excellent at such times

Keep animal comfortable. In cold weather, blanket the animal if the barn is cold or drafty. Use plenty of dry bedding to keep the animal off cold floors Warm the drinking water slightly. In hot

weather provide shade and keep off the flies by means of a fly repellent

Give laxative, if necessary If the bowels are not moving freely, give the animal a drench of Epsom salts solution The dose is about 1 to 1¼ pounds for each 1000 pounds live weight Thus, a Jersey cow weighing 800 to 900 pounds requires ¾ to 1 pound at a dose,

FIG 16.3 Bedding stalls deeply with clean shavings or a combination of shavings with straw on top aid in keeping cows comfortable and in preventing injuries to their udders (Agricultural Photo Library)

while a Holstein needs 1¼ to 1½ pounds Weigh out the salts and dissolve in 2 to 3 pints of hot water Cool to body temperature and pour into a long necked bottle

To give the drench, have a helper raise the animal's head by a halter With the left hand, grasp the nostrils of the cow and insert the neck of the bottle into the side of the mouth so that it rests on the middle of the tongue If the animal coughs, lower the head at once to prevent the liquid getting into the windpipe

Controlling infectious diseases Some of the chief diseases and ailments of dairy cattle are briefly described in the following sections Every dairy farmer should be well informed concerning the nature of these ills and the steps which should be taken in their con-

trol It is to the mutual interest of both consumer and producer of milk and meat that diseases of an infectious nature which might be carried by these food products be controlled or eradicated For this reason many control programs have been inaugurated by the Federal Government for execution by the Secretary of Agriculture and by the states for action by state livestock sanitary boards

So great are the potential dangers of economic loss to the livestock industry in this country should any serious disease get out of control that federal officials not only administer inspection of carcasses slaughtered at large packing plants and rigidly inspect cattle and meats imported from other countries but they also cooperate with neighboring countries in programs for the control of outbreaks of serious illnesses such as foot-and-mouth disease, which may occur in those countries The historic attitude of officials in this country toward infectious diseases has been to attempt to eradicate the diseases rather than to adopt plans for living with them For example, in some countries plans for control of such diseases as brucellosis, foot-and mouth disease, and tuberculosis are in force rather than the eradication programs which are in effect in the United States

Brucellosis This is a highly infectious disease which is spread rapidly from one animal to another It is characterized by birth of the fetus or developing calf, most frequently during the fifth, sixth, or seventh month The fetus is usually born dead

The most common ways in which the disease is spread are (1) the introduction of infected cattle into the herd, (2) through contaminated feed and water, and (3) through licking or eating of the discharges of diseased animals The time at which there is greatest likelihood of spread of the infectious organism is when an abortion or normal calving occurs Contrary to early supposition, the herd bull is not one of the important factors in the spread of the disease, although he may carry the organisms in his reproductive tract and serve as a source of infection

The inroads of brucellosis may cause disastrous losses to a dairy farmer because of (1) loss of the calf crop, (2) reduced milk yields (one-half to two thirds of the normal yield), and (3) the possibility that some cows may not readily conceive or may become sterile following an abortion caused by brucellosis Other untoward effects of this disease are the possibility that the disease may be contracted by other livestock particularly swine, and in a modified form by humans In man the infectious organism of brucellosis causes a debilitating disease known as undulant fever

No effective curative treatment for brucellosis has yet been found Control consists chiefly in (1) prevention that is, avoiding the introduction of infected animals into the herd (2) the adoption of an approved eradication program, once the disease has entered the herd and (3) carefully conducted sanitation measures in the care of the herd

Brucellosis may be detected in cattle by tests of their blood The test is known as the agglutination test or more commonly, the blood test Accurate tests can be made only by experienced persons The test is reliable except under abnormal or special conditions, such as immediately before and after calving and in case of recent exposure to the disease There is sometimes an advantage therefore, in having the test repeated in 30 to 60 days A test of the herd milk, known as the milk ring test or screen test, may be carried out on a can of mixed herd milk to determine whether or not the infection is present in a herd If the test is positive, it may be followed by making the usual blood test of each cow in the herd

In 1934, the Federal Government undertook a program in cooperation with the states for the eradication of brucellosis During the first few years in which the program was in operation, the plan followed was similar to the tuberculosis program namely, (1) testing of herds, (2) slaughter of animals giving positive reactions to the test, and (3) payment of indemnity to the owner for cattle slaughtered The indemnity payments were made jointly by federal and state treasuries and were limited to those states which appropriated money for the purpose The work was carried out on an area basis usually with a county as a unit area

Under this program millions of cattle have been blood tested and thousands slaughtered Of the cattle tested in 1935, 11 5 per cent reacted positively to the test while in recent years the number of positive reactors has been less than 4 per cent When a herd enrolled in the federal state program of brucellosis control has been found on a specified number of successive tests to be free from the disease, it is certified as a brucellosis free herd and when the number of infected herds in a testing area (county) has declined to the required level or below, the county is given certified status To reach the certified brucellosis free herd status the usual requirement is that all animals in the herd 6 months of age or over pass at least two annual negative tests for brucellosis and a certificate be issued by the State Department of Agriculture

A second method of dealing with the disease, namely, vaccination of calves between the ages of 4 and 8 months, was undertaken by the U S Department of Agriculture in 1941 Vaccination of adult cattle was also undertaken on a limited scale At present four plans of brucellosis eradication are in operation

"*Plan A* Use herd test and slaughter reactors with or without calf vaccination This has the advantage of being a short-time program for lightly infected herds which may be cleaned, and kept clean after limited testing Calf vaccination may be advisable in some clean herds surrounded by heavily infected ones The plan calls for prompt removal of reactors thorough disinfection, and retests at 30-day intervals

"*Plan B* Test the herd vaccinate the calves and retain the reactors until they can be sold for slaughter without heavy loss to the owner Get rid of reactors reasonably soon, leaving in the herd vaccinated, growing heifers with increased resistance

"*Plan C* Vaccinate calves without testing the herd This plan is suited to range herds or those in which the movement of animals is governed by special permits issued by state livestock sanitary officials

"*Plan D* Vaccinating adult cattle To be used only upon approval in writing by state federal supervisors before testing begins It should be used only as an emergency measure in herds where danger of spreading infection is very great [1]

The plans of carrying on the brucellosis clean up program differ from state to state Attention should be called to the fact that in some states Plan A, as outlined above, is the only one permitted on a farm which desires to qualify for the production of Grade A milk A further restriction is that in some states a negative blood test is required for all cattle sold except those sold for immediate slaughter

The future outlook for the control of brucellosis seems bright as long as controls and testing are continued Should restrictions be relaxed, however, the situation might soon get out of hand It is essential for the success of the program that rigid sanitation accompany testing The procedures of isolation of diseased animals the prompt disposal of dead animals, and the disinfection of the premises, as outlined in the foregoing sections must be strictly carried out

Tuberculosis This disease affects the lungs or almost any of the organs or tissues of the body It is caused by a specific germ which may be transmitted from animal to animal Young animals may be

[1] Kuttler A K *Progress Report on Brucellosis Eradication* 1952 U S D A

infected by drinking milk from cows which have infected udders The disease in cattle is a public health problem because members of the human family, particularly children, may be infected from drinking milk from tubercular cows and both children and adults may contract the disease through raw or improperly cooked meat

There are usually no outward symptoms until the disease is in its most advanced stages The only certain and practicable method of ascertaining whether or not animals in the herd are affected is to have a competent veterinarian apply the tuberculin test Although the test may be administered in different ways, the form most commonly used is known as the intradermal test A small amount of tuberculin (a serum containing no living bacteria) is injected into the skin near the tailhead A positive test is indicated by a characteristic swelling within a specified number of hours after injection

There is no known curative method for treating the disease in cattle Control and eradication consists in slaughter of the animals which have been identified as reactors by the tuberculin test As a result of an extensive program of eradication which was begun by the Federal Government in 1917, the amount of infection has been reduced from an estimated 4 per cent of all cattle and 25 per cent of the cattle in some areas to less than 0 5 per cent of the cattle in each state This outstanding achievement merits the thanks of every person in the nation, because simultaneously with the reduction of tuberculosis in cattle herds, the number of cases of tuberculosis in children has shown a great decrease

The eradication program is conducted in much the same way as that used in the early part of the brucellosis campaign, namely, test and slaughter on an area basis with federal and state indemnities for reactors Certificates of accreditation for herds having no reactors after a specified number of tests are issued by state livestock sanitary officials

The program of eradication is furthered by the federal meat inspection service which is carried on at every large meat packing plant When tuberculous carcasses are found, the origin of the cattle is determined and the infection in the herds is eradicated by test and slaughter

Even though the incidence of tuberculosis has been reduced to a low point, there is still potential danger from the few cases which remain It is therefore of utmost importance that every dairy farmer at all times carry on an active sanitation program in the management of his herd Milk or whey purchased from a creamery or cheese

factory for feeding should be thoroughly pasteurized before being used. Newly purchased animals should be purchased from an accredited tuberculosis-free herd or after passing a negative tuberculin test. The cattle should be subject to retest within 60 to 90 days. Furthermore, it is essential that all milk be pasteurized or boiled and all home-killed meat be thoroughly cooked before consumption by the farm family.

Mastitis. This term is usually applied to an infectious disease of the udder which is caused by the entrance of certain bacteria through the teat canal. The infection is spread from one cow to another by the hands of the milker, by towels or rags used in cleaning the udder, by the teat cups of the milking machine, and by soiled bedding or floors on which the milker has discarded milk from one or more of the affected quarters.

The first indication of the disease is thick, stringy, or lumpy milk which clogs strainers. As the condition becomes worse, one or more quarters of the udder may become hard, with an inflamed appearance and the cow may have a high fever with loss of appetite. If not corrected, the disease often results in loss of the affected quarters and the cow may become unprofitable. Within a few weeks' time, the disease may spread throughout the entire milking herd. Not only is milk yield reduced, but the presence of thick, stringy, or lumpy milk in cans of herd milk usually render the milk unsalable.

As with a number of other diseases of dairy cattle, the best way to combat mastitis is through an intelligent sanitation program which is scrupulously observed at every milking. The colleges of agriculture and veterinary medicine of the University of Illinois have recommended the following program for the prevention and control of mastitis: [1]

1. *Use correct milking procedures.* Incorrect milking spreads mastitis germs from one cow to another. Healthy udders of cows milk with greater ease, produce more milk, and are most resistant to disease.

2. *Use the strip cup daily.* Cows giving flaky or clotty milk can be identified by this method It also aids the let-down of milk, and the foremilk with high bacterial count can be discarded.

3. *Milk infected cows last, and feed carefully.* Put infected cows at end of the milking line. Reduce grain rations, and supplement with bulky and laxative feeds. Dispose of badly infected animals.

[1] A Herd Program of Mastitis Prevention and Control. Ext. Ser. in Agr. and Home Econ., U. of Ill.

4 *Have milk samples from all cows in the herd examined in the laboratory* Identification of all mastitis infected cows and those harboring mastitis germs is necessary before you can begin to control mastitis effectively

5 *Do not buy infected animals* Have the udders of all newly purchased cows examined and samples of their milk tested before the animals enter the milking line First calf heifers are usually mastitis free

6 *Use deep bedding* Deep bedding decreases the possibility of injury to teats and udders as well as exposure of udders to cold, damp floors

7 *Treat teat and udder injuries promptly* Cleanse the wound and apply a 5 per cent sulphanilamide ointment

8 *Keep cows and barns clean, and avoid muddy lots* Mastitis-producing bacteria live in filth Drain muddy lots, and fill holes with cinders or gravel

9 *Prevent calves from sucking one another* This bad habit breaks the seal which closes the teat canal Tie calves to a stanchion, or post, for a short time after feeding

10 *Have selected cows treated* Not all infected cows respond to treatment Cows recently infected or showing only a few hard spots (fibrosis) are most likely to recover following treatment The best results are obtained from treatment during dry periods or near the end of lactation Cows which recover following treatment may become reinfected if preventive measures are ignored

A number of curative treatments for mastitis have been developed and appear to afford beneficial results when properly administered The treatments consist of injecting such compounds as penicillin, tyrothricin, streptomycin, aureomycin, bacitracin, and sulpha drugs through the teat canal into the affected quarters of the udder The treatment is best given by an experienced veterinarian after samples of milk from each quarter have been examined in the laboratory for character and extent of infection

Even though curative treatments may be used, there must be no relaxation in the program of rigid sanitation and good herd management Providing comfortable stable conditions without cold drafts and ample dry bedding preventing injuries to teats, milking rapidly and gently with proper adjustment of the suction of milking machines, and completely sterilizing the teat cup after each milking are essential procedures which must be faithfully performed

Bloat The bloating of cattle when on pasture is one of the drawbacks to the pasture method of feeding, as occasionally serious losses

result from this cause. As a rule, more cases of bloat occur on legume pastures than on grass pastures. Bloat, however, is not confined to the pasture season, since cows given feeds which have become musty or moldy or are in a fermenting condition may become bloated.

Bloat is indicated by an abnormal distention of the middle of the animal, with a firm, taut feeling of the hide over the upper part of the flank, especially on the left side. The hide may be stretched so tightly that striking the animal at this point gives a sound like that of a drum. The animal appears to be in pain and has difficulty in breathing The cause is the retention of gas which is normally produced in large quantities by ruminants. The usual avenue of escape is by way of the esophagus and mouth, but when this passage becomes blocked and the gas continues to form, pressure is built up which may cause the animal to suffocate within an hour or two.

Some cattle are chronic bloaters, that is, they bloat frequently to a limited extent and recover without treatment. Other animals may recover from moderately severe attacks if feed is kept from them for several hours. In severe cases, treatment must be prompt. As a last resort, using a trocar and cannula, tap the rumen at a spot on the left side equally distant from hip bone, last rib, and backbone, to permit escape of the gas This treatment is best applied by an experienced veterinarian.

Preventive measures include the following:

1. *Give cattle a full feed of hay, silage, and grain,* or *hay alone,* before turning them to pasture the first time in the season.

2. Make the change from barn feeding to pasture feeding a gradual one; for the first few days, leave cattle at pasture only 1 to 1½ hours daily.

3. When cattle graze legume pastures, keep a supply of hay or straw in a rack to which they have free access A rack on wheels which can easily be moved has been found useful. It should be kept in the center of the grazing area.

4. For the first grazing in spring, use only grass pastures; delay grazing of all-legume pastures until the bloom or early haying stage.

5. Grow mixtures of grasses and legumes if all-season grazing of pastures containing legumes is desired When grass-clover mixtures are used, particularly mixtures of grass and Ladino clover, the mixture should contain at least 50 per cent grass. Tall fescue, in the areas to which it is adapted, has been found one of the best grasses for use with Ladino clover, presumably because of the tough, fibrous nature of this grass. *Growing a high proportion of grass with the*

legume is considered the most practical of all methods of bloat prevention

6 Keep cattle from pastures when frost is on them and for an hour or two after frost has disappeared

7 Provide a readily accessible supply of fresh water and mineralized salt

Foot and mouth disease, anthrax Outbreaks of these highly contagious diseases have occurred in recent years Regulatory officials should be notified whenever a disease of unknown nature affects the herd

The usual procedure in dealing with these diseases is quarantine of the farm slaughter of the herd (in the case of foot and-mouth disease), and complete disinfection of the premises The best safeguard of the individual herd owner against such infections is a careful sanitation program as heretofore described although in recent outbreaks of anthrax the feeding of imported bone meal which had not been sterilized was said to have been the source of infection

Preventing milk fever The role of herd management in the prevention of milk fever is discussed in Chapter 11

Preventing calf ailments Methods of preventing calf scours and other ailments of calves are outlined in Chapter 14

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Leaflet 75 Warts on Cattle 2?0 Horn Flies 283 Fly Control on Dairy Cattle and in Dairy Barns

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REVIEW

1 Why is sanitation such an important feature in the care and management of a dairy herd?

2 Give directions for the removal of manure and the cleaning of stables

3 Mention the details to be observed in providing good feed and clean water for the dairy herd

4 What procedures should be used in protecting the dairy herd from neighborhood infections?

5 What precautions should be observed in the disposal of dead animals?

6 Give directions for the disinfection of a barn after the occurrence of an infectious disease

7 Discuss the relation, if any, of good rations to health in dairy cattle

8 How can suitable protection from weather extremes be provided?

9 Mention the kinds of harmful materials which dairy cows may eat and how these dangers may be avoided

10 List five principal procedures which should be observed in rendering first aid to sick animals and give details of each

11 Describe the (*a*) effects (*b*) cause, (*c*) ways in which disease is spread, (*d*) detection and (*e*) methods of eradication or control of *each of the following* diseases brucellosis, tuberculosis and mastitis

12 Discuss bloat in cattle Give cause, symptoms, and preventive measures

17

Fitting Animals for Exhibition and Sale

Perhaps at the outset it is desirable to make a separation between purebred registered animals and grade cattle when discussing the subject of fitting and showing

When grade cattle are sold traffic is almost entirely in females and the primary items of importance to the purchaser are (1) What prospects do they have for producing milk? (2) What is the age and probability of future productive life in the individual? (3) Are the animals free of disease and in good general health? (4) When did they last calve or are they carrying calf? (5) What is their physical condition that is are they in good condition or thin in flesh? Many of these items are interrelated furthermore they are associated with good husbandry However grade cattle do not require or justify an expenditure at least not any considerable expenditure of energy or money to improve their physical appearance beyond that required for effective performance

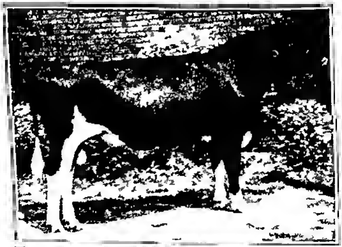


FIG 17 1 This young bull was named All American Jr Yearling 1951 He is well fitted and well posed His head is held in the correct position and he is standing with his feet well placed under him

With purebred registered cattle the situation is different. Such animals are frequently exhibited at shows. Quite often they are sold either in consignment sales or dispersal sales. Under such conditions, especially in consignment sales, they are in competition for the eye appeal of the purchaser. What he is willing to pay for an animal or whether he is interested in the animal at all depends upon the impression he has when he first surveys the individual. Under such conditions fitting and exhibiting assumes an important role in merchandising.

Furthermore, junior shows at the county, state, and national level are gaining in public interest and acceptance. They provide an excellent opportunity for young people to form concepts about the strengths and weaknesses of animals and what is probably more important, how good the best animals are. Many young people have had their goals or standards raised while participating in shows because they have had the opportunity to view superior animals and the privilege of exchanging ideas with the other participants who had developed and exhibited the best individuals.

The procedures to be followed in preparing and presenting animals is essentially the same irrespective of the objectives to be attained.

Choosing animals. Whether for sale or exhibition the choice of animals should be made with care and by the exercise of good judgment. A responsible person who values his reputation will never offer for sale an animal that he is aware is defective or that will leave the prospective buyer disappointed with his purchase. A good breeder sells his cull animals to the butcher.

Likewise, a thoughtful breeder will select only such animals for exhibition as are reasonably certain to create a favorable impression upon the observers or other exhibitors at the show. Inexperienced exhibitors may have formed the opinion that it requires a large exhibit to be impressive. But wise showmen know that five or six outstanding animals create a much more favorable impression than twenty or more ordinary animals or even the six outstanding ones and fifteen more that should have been kept at home.

Select animals that are well developed for their age. Animals placed on exhibition are usually somewhat larger than the average for the breed. In selecting animals for exhibit, therefore, choose only those which are well grown and at least equal in size to the average expected for the age and breed. Extremely small animals, even though they may be especially smooth and fine in type, are undesirable for exhibit; on the other hand, unusually large animals are often coarse and unsymmetrical and should be rejected.

Choose animals with refinement and capacity. It is desirable to select animals that have graceful well-blended lines with finely chiseled features and symmetrical parts The withers and shoulders should be snugly held to the body and the ribs should be well sprung, especially in the crops and back over the loin The bone should show plenty of substance yet be flat and dense The joints, especially at the hocks, should be clean and free of puffiness The legs should be reasonably straight, the feet should point forward and be clean at the hoof heads, and the pasterns should be strong

In milking animals favor good, sound udders Udders should be durable A strong forward attachment that is held tightly to the body and a high wide rear udder attachment are always favorable qualities The median support should be strong enough to hold the quarters of the udder plumb without sagging in the center and the teats ought to point straight downward Capacity of udder is determined somewhat by size but largely by texture The best udders are usually medium in size, stage of lactation taken into account

Place emphasis upon strong toplines and level rumps Highly regarded dairy animals have good conformation together with ample depth and capacity Seldom do animals stand high in the show ring or sell well when offered at auction sales unless they are desirable in form and give the impression of being rugged or durable

Avoid any serious defect Even though an animal is otherwise acceptable, do not attempt to exhibit it if it has a serious defect for example, one quarter of the udder not functioning (blind), a badly sloping rump, decided permanent lameness, or crampness, blindness, or any other serious bodily defect

Get the animal in proper physical condition Many excellent animals are overlooked when the show herd is picked or when purchases are made because they are extremely thin in flesh Such animals appear to lack capacity, give the impression of being frail, poor feeders, etc It does take longer to condition such animals and bulls usually require more time for conditioning than heifers When such animals are in condition, however, the rewards usually justify the effort

Condition usually includes such items as putting on flesh, improving the gloss of the hair, developing body, improving the alertness or attitude of the animal, etc All of these items add to the attractiveness and value of the individual

Heavy milking cows are very difficult to put in good condition Large yields of milk require so high a percentage of the total nutrients

consumed in the feed that such cows more often lose than gain weight in the earlier stages of their lactation. It is therefore necessary to plan much longer in advance of a show or sale when preparing a milking cow.

Conditioning usually requires liberal grain feeding. The amount of grain that should be fed depends upon the condition of the animal and the length of the feeding period. Very thin animals should have their grain ration increased gradually until they are consuming all of the grain they will quickly clean up after having had free access to good roughage. Well-fleshed animals on the other hand require only enough grain to give them bloom and hold their flesh.

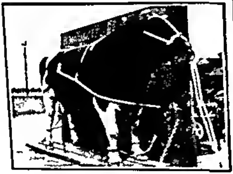
The following mixture has produced good results as a fitting ration:

	Lb.
Ground oats	150
Wheat bran	150
Ground corn or hominy	300
Linseed meal	100
Salt	7

If the animal is very thin in flesh, add 200 lb. of ground corn and 50 lb. of linseed meal. If the animal is in good condition, reduce the corn to 150 lb., increase the ground oats 100 lb., and the bran 50 lb. It is well to accustom the animals to eating this mixture in the form of a rather thick slop. This is done by adding water and molasses, about 1 part by volume of molasses to 5 parts of water. This method of feeding keeps the animal in better physical condition, it is less likely to go off feed, and a deeper body with more capacity is attained.

Avoid patchiness and overcondition. Care must be taken not to get the animals in too heavy flesh, or they may become patchy; that is, fatty deposits may appear about the tailhead or over other parts of the body. When the animals are in proper condition, and before there is evidence of any patchiness, lighten the ration by putting in more bran and oats. At the same time reduce the amount of corn or hominy and linseed meal as well as the total amount of grain. If animals are too well fitted at the beginning of a show season, they frequently "go bad" before the later and more important shows, that is, they become too beefy in appearance, appear coarse and lacking in refinement, and create a generally unfavorable impression on the judge or buyer.

Fig 17.2 This device has proven very satisfactory for trimming hoofs of dairy cattle The stall is made of 2" O D pipe welded together The horizontal pipe which is visible is located about 28" from the floor level Total height is 6 and the floor consists of 3" oak planks fitted into the angle-iron base These planks can be removed when the equipment is to be moved



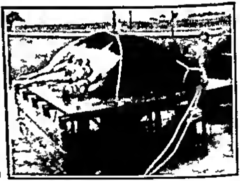


Fig 17.3 and Fig 17.4 This device was developed by a practical dairyman Douglas Knights of Sandwich Illinois It shows how large difficult to-handle bulls and cows can be easily controlled while their feet are being trimmed The animal is fastened to the platform while in a standing position The table is then moved into a horizontal position by a specially geared mechanism and tractor or motor power thus placing the feet of the animal in easy access to the workman

Get your animals ready for a show or sale. A skillful exhibitor pays careful attention to training, trimming feet, clipping, washing, blanketing, and preparing his animal for the ring. Many of these items can and should be done at the farm before the animal is taken on the show circuit or to a sale.

Train animals to lead well. Animals, both male and female, should be taught to lead when they are young. They are much easier to handle then and learn more quickly. While walking, the animal should hold its head with the nose several inches above the withers and the head should be pointing directly forward. It should lead freely and willingly and at a slow pace. It should come forward with a slight pull on the lead strap, and back with a slight pressure on the halter together with a slight pressure on the shoulder with the free hand.

All animals should be taught to pose. Teach the animal to take a good position. It should stand naturally and squarely on its feet. The head should be held well up and naturally. Study the poses that best display the animal. Avoid getting the rear feet together and under the animal or pulling on the nose ring of a bull until his nose points out in front and his face is almost parallel with the ground. Figure 17.1 illustrates a good pose.

Trim hoofs carefully. Of all of the tasks connected with fitting and showing, hoof trimming is most likely to be neglected. Yet it is one of the most important items in preparing an animal, especially for a show. It is necessary in older animals to have some device for restraining the animals during the hoof-trimming process. A simple and at the same time highly satisfactory piece of equipment is illustrated in Figure 17.2. A more elaborate device is portrayed in Figures 17.3 and 17.4. This latter equipment is highly desirable for trimming the feet of mature animals, especially aged bulls.

Irrespective of the restraining device used or the age of the animal, the feet should be trimmed so that the toes are short and well rounded and the bottom of the foot is flat and rests evenly and naturally on the ground. The art of trimming feet properly comes mostly from observation and practice. Figures 17.5 and 17.6 convey the idea of how feet are trimmed.

Clip animals carefully. It is seldom advisable to clip an animal over the entire body. If some of the hair is extremely long with other areas short and rough and the time for fitting is short, it may be desirable to clip the entire animal. Even then do not clip animals that are thin in flesh, as clipping tends to make them look thinner. When

Fig 175 Shows how two men can work together in trimming the rear feet of a large cow Each has a sharp wood chisel and mallet The cow stands more quietly if both feet (rear or front) are worked on at one time

such clipping is necessary it should be done 6 to 8 weeks before the first show or sale except in the case of young well fleshed animals when it may be done any time before sale or show When the condition of the hair over the body is satisfactory clipping should be done only on the underline (except in the Ayrshire breed) on the neck and head the tail and occasionally along the higher processes of the back and over the withers It is the custom of Ayrshire breeders to clip only the heads necks and tails of their exhibition animals

In clipping the tail do not clip too low on the switch as this detracts from the appearance and symmetry of the animal Irregularities on the back may be made less conspicuous by clipping the hair short on the high spots and leaving it unclipped over the depressions If withers are to be clipped at all they should be clipped from both es in such a way that their sharpness will be accentuated

FIG 17 6 Not only is it necessary to trim the outside of the hoof as indicated in Figure 17.5 but also the bottom or sole must be leveled off Special hoof trimmers like those illustrated are very helpful for this purpose The restraining device is similar to that shown and described in Figure 17.2

Keep show animals blanketed The continued use of a blanket on an animal to be *exhibited* prevents soiling and staining and makes the hair lie down more smoothly It protects the animal against drafts, sudden changes in temperature, and in summer against flies and insects A lightweight duck or burlap blanket is best for this purpose In cold weather it may be desirable to use two blankets, such as the ordinary stable blanket with a flannel blanket underneath

When horns are present, smooth and polish them. If horns are too long, from three-fourths to one and one-half inches of the tip

may be removed, providing it is done 6 to 8 weeks before the animal is to be exhibited

Large horns and those badly marred should be scraped or rasped down until they are smooth and shapely A small wood rasp is usually best for this purpose Any marred places that still remain may be taken out with a horn scraper or a piece of glass After the horns have been rasped they should be smoothed with emery cloth, first with the coarse cloth and later with the fine

Upon the smooth surface of the horn place a thin coating of tripoli powder and sweet oil mixed to the consistency of a thin paste Polish with a strip of flannel cloth Two or three such applications and rubbings should bring out a very high polish When time is limited, horns that have previously been smoothed down and polished may be given a thick coating of olive oil This gives a glossy polish, especially at night, but such a polish will not last for more than half an hour

Exercise care in trucking or shipping animals It is highly important that animals arrive at their destination in good condition The results of careful fitting can be lost in a single shipment if animals are not properly cared for when in transit

Disinfect car or truck before loading Except in a new car or truck that has not been used for livestock shipments, thorough disinfection should precede loading Any of the ordinary disinfectants, such as carbolic acid, cresol, lye, etc , are satisfactory for the purpose Before such disinfectants are applied, the truck or car should be thoroughly cleaned out and scrubbed After the surplus water has been removed, disinfecting materials may be used as a washing solution or sprayed on the sides and bottom of the car or truck These *same precautions* apply to the transfer of animals from one herd to another It is only in this way that all communicable diseases can be avoided

Protect animals against shipping fever It is good husbandry to protect animals against shipping fever when they are taken to a show or sale Perhaps the best protection if done in time is injection with the bacterin This should be done at least 4 weeks before the animal is moved from the farm This method gives very little protection unless done well in advance of exposure In the event that protection must be given just prior to shipment, the serum not the bacterin, should be used It is best that either treatment be administered by a qualified veterinarian

Be sure that health papers are in order. Every animal exhibited at a show or offered for sale should be in good health and free of communicable diseases. If shipment is to be made interstate health papers must be available for inspection. Such papers are usually obtained through your local accredited veterinarian.

Final preparation for the show or sale. The careful showman makes sure, before he beds the animals down the night before a show, that he has done what he can to prepare for the following day.

Junior exhibitors especially should braid switches. The evening before the exhibition, wash the switches of the animals thoroughly with soap and water and then dip them into a pail of water to which has been added a small handful of powdered alum. Alum water tends to make the tail fluffy when combed out for exhibition. Braid the switch into a number of small braids, and wrap these braids together and cover with a cloth to prevent soiling.

Withhold water. The evening before the show, do not allow animals that are to be exhibited to have access to water. The purpose in withholding water is to make reasonably sure that the animals will take on the desired "fill" at the time of exhibition. As an added stimulant to thirst, a double handful of salt should be given to each animal the night before the show.

Bed down heavily. While animals should be well bedded at all times, it is especially important to keep them clean the night before the show. Oftentimes an attendant is on duty during the night preceding the show to remove the soiled bedding.

Do not overbag milking animals. Great care should be taken in deciding how much milk an udder should contain to enable the animal to appear at its best. Usually cows are overbagged. The cow should be milked out before the show or sale at a time when the proper amount of milk will have accumulated when the animal goes into the ring. This might be 6 hours or it might be 16 hours. It is perhaps a good practice in a preliminary test to bag up the cow a few days before she is to be exhibited and, as the udder fills, to watch carefully so that you may note the proper timing between milking out and the most desirable shape and size of the udder.

Clean animals thoroughly and get equipment in readiness. On the morning of the show, animals should be cleaned thoroughly. The udders of milking animals should be eased off preparatory to bagging This will tend to prevent "hiving" or the skin from rising up in small welts over the body. At this time, also, get in readiness such equipment as halters, lead straps, bull staffs, etc. Pails should be filled

with water properly tempered, in readiness for use when animals are filled

Feed carefully. On the morning of the show do not give a large quantity of feed at one time, as this tends to make animals sluggish. Small amounts of grain fed at frequent intervals together with the animals' desire for water, will tend to keep them alert.

"Fill" to desired fullness Usually about half an hour before an animal is to go into the ring it should be filled. This may be done

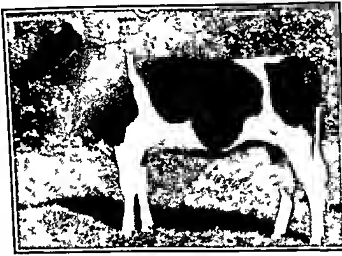


FIG 177 This Holstein heifer shows excellent fitting and preparation for the show ring. Note the admirable clipping job, the clean white hair and the glossy black areas. This animal is fitted almost to perfection

with water or with a thin gruel or slop feed. If the weather is cold, take the chill from the water, otherwise the animal will hump up its back and shiver. Too much water is to be avoided as it tends to distort the appearance of the body and makes the animal difficult to show. Take charge of this operation yourself. It should not be left to a stable boy who does not know when the animal is properly filled.

Give horns final polish, and rub down hair Immediately after the animal is 'filled' the horns should be given their final polish, the hair should be rubbed down, and the show halter put on. Figure 177 shows a well-fitted 4 H club heifer. The animal is now ready for the ring.

Exhibit animal to best advantage in the ring An animal should appear at its best at all times when in the ring. If it has been well trained it can be made to take and hold the various positions which have been studied out as showing its good points to the best possible

advantage. While in the ring, keep your eyes on both the judge and the animal. When a meritorious animal is not being noticed by the judge, the exhibitor can sometimes attract the attention of the judge by moving his animal into a more advantageous position.

Show a spirit of sportsmaoship. It is a deep disappointment to lead an animal into the show ring and have it fail to place, or place lower than is eootemplated. This situation is made more difficult especially for the beginner, because many of his or her friends will, without much thought of truth or consequences, assure him that his animal is "outstaoding and should wio." Many heartaches have resulted over such unwarranted statements.

Judging is a matter of opinion. Opinions differ and the beginner should recognize this fact Furthermore, competitioo, especially in 4-H and vocational agriculture classes, is keen and decisions must be made on small differences. Animals, especially young animals, change greatly from week to week. An animal that placed first at one show may be "well down the line" in another, and the judges in both cases may be equally competent.

These facts make it appear desirable to have group placings, sometimes referred to as the Danish system, so that animals of essentially equal merit may be giveo the same rating. By this plan there might be several animals in group one or the judge might conclude that none of the animals merit so high a recognition and place none in *the first (blue ribbon) group but several in the second (red ribbon)* and others not so desirable in the third (white ribbon) group. This system is recommended to those responsible for the conduct of large 4-H shows and parish breed shows.

Sportsmanship is a valuable asset to anyooe. Do not become discouraged when your animals do not win. It is better to try to determine why they did not create a favorable impression upon the judge. Furthermore, learn to recognize and appreciate merit in another's animal. Do not overestimate your own. Congratulate the person who has a really good, well-prepared animal, and resolve to put more effort into the next show.

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REVIEW

1 What qualities should be considered when selecting animals to be exhibited?

2 Discuss the characteristics of a good sound udder

3 What is meant by getting an animal in good physical condition?

4 What is a good conditioning ration?

5 Why avoid overconditioning?

6 Why should animals that are to be exhibited or sold be kept under blanket?

7 *How do you train an animal to lead and pose?*

8 Why should cars and trucks be disinfected?

9 How do you protect an animal against shipping fever?

10 What points are emphasized in preparing for the show?

11 What is your idea of sportsmanship?

18

Merchandising Dairy Cattle

As long as cattle are produced they will be bought and sold. If a dairyman establishes a new herd, he must purchase one or more animals. It requires approximately 60 per cent of the females born in an established herd to maintain numbers; therefore, from 20 to 40 per cent constitute surplus and must be disposed of. Furthermore, few breeders or dairymen are entirely satisfied with the quality of their animals and from time to time will want to add superior individuals or better germ plasm to their herds. On the average dairy farm the bull calves are generally regarded as surplus and most of them are sold as veal, but, in the more outstanding purebred herds, young bulls still constitute a highly salable product.

Dairy cows have three sources of value. These are (1) for beef, (2) for milk production, and (3) for breeding purposes. These three values are somewhat correlated, yet they can be differentiated from each other. The beef value is quickly recoverable and quoted on a daily basis. Except for the minor differences that are possible in alternate markets, the dairyman sells his animal for beef on the basis of the market quotation for that day. Such a market is always available and marketing facilities reach the individual farm.

If a cow is sold for milk production, then the transaction is between the buyer and the seller. Some salesmanship is required, and valid evidence of worth is highly desirable. If breeding value is an added consideration, as it is in merchandising purebred cattle, the selling problem is even more important, and salesmanship together with a highly desirable animal is an asset to the breeder.

Make it a point to buy only sound healthy cattle. It is not possible to eliminate all of the risks one must take in buying cattle. The health hazard is the most important single consideration the purchaser should have in mind when he adds an animal to his herd. Not only does he risk the possible loss of the animal that he has bought, but, what is much more important, that animal if infected might endanger the health of his entire herd.

Insist that all purchased animals be free of tuberculosis, infectious abortion, and, if cows, mastitis also. There are recognized standard procedures to test animals for evidence of the presence of any of the above named diseases. The intradermal test for tuberculosis can be applied by any qualified veterinarian. It is highly reliable in detecting the presence of that disease. Agglutinins in the blood of animals infected with Bang's disease (*Bacillus abortus Bang*) make it possible to test for that disease also. All animals brought on a farm that is free of the abortion disease should be negative to the Bang test. Mastitis is somewhat more difficult to identify. No single test is quite as reliable in diagnosing the presence of mastitis as are the tests for tuberculosis and Bang's disease. The bromothymol blue test and other reduction tests are helpful in identifying chronic cases. Active cases can sometimes be found by using a strip cup to locate coagulated particles of milk or by palpation (examining the udder by carefully feeling the tissues). Acute cases can be observed by noticing the swelling and hardness of the quarters of the udder.

If any of the tests are positive (indicate mastitis), then it would be desirable to have the opinion and approval of a competent veterinarian before the animal is purchased.

Buy only superior animals. It is almost always more desirable to limit the number of animals purchased than to accept individuals of doubtful value. Good judgment in evaluating animals and in setting maximum prices that a purchaser ought to pay for an animal are important considerations. Average breeders, and especially 4-H and Vocational Agriculture members should not go beyond their means in buying an expensive registered animal. Nor, in contrast, should they invest money in an inferior animal just because it is priced at a low figure. It is better not to purchase a single animal, if its loss would endanger the financial status of the purchaser, than to buy it and assume that risk.

In deciding how much an animal is worth to you, apply this rule: if a cow is five years or less in age it is safe to pay as much for her as her milk for one lactation would bring on your market. If the animal is registered you might add to the milk value the value of one of her heifer calves at six months of age. It seldom pays to invest in an animal whose production is much below the average for the breed and age class that she represents.

Familiarize yourself with the facts that determine the kind of cattle that you should buy. What breed, age, and quality of cattle

will best serve your purposes? Do you expect to breed and develop your own replacements? Are you a young man with limited capital or past middle age with a great urge to develop an outstanding herd? It is answers to questions of this nature that will determine the kind of cattle you want to buy.

A young man with limited capital can grow into the dairy business. If he buys a few really desirable animals the natural increase from these individuals will in time provide him with the number of animals he desires. The man of middle age or older does not have the time to follow this procedure. He must invest capital and obtain a relatively large herd in the beginning, if he wishes to become a successful and recognized dairyman.

The authors are often asked this question: Which is it more profitable to buy, heifers, milking cows in their prime, or older proven cows that frequently have defective udders or are otherwise damaged but still capable of producing desirable offspring? There is usually a greater selection if heifers are purchased. It is also true that less real information is available about them; more must, therefore, be left to chance. The price asked, especially for heifers that are of breeding age but not in calf or for in-calf heifers that are several months from calving, is usually favorable to the purchaser.

Oftentimes very young heifer calves (1–3 weeks of age) from outstanding and highly valuable cows can be purchased at dispersal sales and at relatively low prices. This is possible because the sale is usually held when the most valuable cows look their best. The purchasers of such cows often come great distances and do not care to take the risk of shipping a calf. Furthermore, many of these purchasers have bulls that they regard very highly and are primarily interested in their progeny from the animals purchased.

The most productive and best-looking herds are obtained by purchasing good young milking cows. Such herds are assembled at considerable expense. Seldom are the progeny of these cows as good as their maternal parent. This is to be expected because such animals usually represent the very best individuals in the herds from which they come. The genetic law of regression, in such cases, would place the competence of the offspring at some point between the cow's ability and the average of the herd from which she came. If the genetics of the herd is highly variable and the cow herself is distinctly better than the herd average, the progeny of the cow can be quite mediocre.

In the establishment of purebred herds it is sometimes desirable, if capital is limited, to purchase grand old cows that are safe in calf but have injuries that mar their appearance and materially reduce their value The life expectancy and breeding value of such animals are very likely to be low and these facts should be taken into account in setting a price Such animals when mated to outstanding sires can contribute both foundation females and service sires to a herd It is seldom desirable to purchase more than two to five of such animals when establishing a herd

If inexperienced do not rely entirely upon your own judgment when buying animals One of the common mistakes made by a beginner is for him to assume that, because he has read several articles and visited a few well managed farms, he is qualified to correctly evaluate cows and operate a farm An inexperienced purchaser usually fares much better if he is accompanied by an experienced and competent person when he buys a herd or purchases a farm

It is highly desirable also to deal only with reliable people when purchasing animals There is great opportunity for deception in merchandising cattle Information regarding the character and reliability of the seller may be obtained from bankers, business men, breed association representatives, and dairymen

Select cattle that will improve with age Learn to become a good judge of an animal "in the rough" If animals are carrying a long rough coat of hair and especially if they are thin in flesh, they are usually underestimated as to their real worth Conversely, animals that are sleek and fat and "in bloom" are generally overestimated

In Chapter 3 your attention was drawn to two types of defects, those that improve with development and those that get worse Study especially the characters of an animal that improve with age and development The purchaser who is able to recognize a good animal, with excellent prospects but thin in flesh, will usually find himself the ultimate owner of a good herd that is improving as it develops When it has developed, his neighbors will credit him with having obtained a bargain that others could not visualize

Use effective methods in selling cattle Most high grade and purebred cattle are sold by private treaty The buyer goes to a part of the country where surplus cattle of the kind he wishes to buy are known to be located and deals directly or through an agent with the owner of the cattle A considerable percentage of cattle, especially when herds are dispersed, are sold at public auction No matter

what the method the seller must make known to the purchaser just what he has for sale.

It is advisable to advertise in agricultural periodicals. Because of their extensive circulation, agricultural papers are almost sure to reach prospective purchasers. Advertising in newspapers or in breed publications or trade journals must be skillfully done. In such cases, specific sale announcements or references to individual animals are most effective. Care must be taken that the cost of advertising is not out of proportion to the value of the animals advertised. In such advertisements, as elsewhere, it is necessary to state the truth regarding the animals listed.

Use circular letters and correspondence. Carefully prepared circular letters, when sent to a select mailing list, constitute valuable advertising. Such letters usually take the form of special sale lists and briefly describe each animal offered for sale.

Even when newspaper advertising or circular letters are responsible for inquiries, it is almost always necessary to close the deal by means of a letter or a personal interview. The ability to write attractive and convincing letters is an asset to any breeder, and especially to the owner of purebred cattle. Although letters should be brief and to the point, they should state all the facts that would be of interest to the purchaser. Furthermore, all correspondence should be answered promptly, preferably within twenty-four hours after it is received.

Good pictures and three-generation pedigrees are effective salesmen. Most breeders and dairymen do not make sufficient use of good pictures. There is no description, no matter how accurate, that is quite so convincing as a good clear picture of an animal. It is not necessary that such photographs be elaborate or costly. An ordinary kodak picture is sufficient if the animal is standing in a good position and if taken at a time when the animal shows to advantage.

It is usually highly desirable in marketing registered animals to provide a three-generation pedigree. Such pedigrees should include, in addition to the names and numbers of parents and grandparents, all of the production records and type evaluations available for the animals named. In preparing such pedigrees, avoid the padding and irrelevant information shown in Pedigree B, page 92. Such pedigrees are misleading, are intended to be so, and they disgust the intelligent buyer.

If going out of business use dispersal sales. Dispersal sales are usually convenient ways of selling the entire herd when one is going

out of business Such sales attract more and better buyers than consignment sales when cattle of equal quality are sold Under such conditions the purchaser knows that he has an opportunity to buy the best animals in the herd Such animals are seldom offered in a consignment sale Buyers tend to have confidence in bona fide dispersal sales and will travel considerable distances for the opportunity to make their choice from among all of the animals offered in the sale

Well-managed consignment sales aid the small breeder Breeders who have only a few cattle to dispose of each year find it convenient to combine with their neighbors and market their cattle by means of a consignment sale Such a method has the advantage of marketing the cattle at a definite time and usually to a favorable market

Table 18 1 indicates that records of production are especially

Table 18 1 *Influence of Production Records upon the Selling Price of an Animal*

Cows 2 or More Years of Age

Year	No of Animals	With A R. Records	No of Animals	No Record Out A.R. Dam	No of Animals	No Record Dam without Record
1944	1397	$510 35	1323	$425 45	1422	$267 57
1945	1475	585 45	1275	488 12	1908	304 48
1946	1437	712 81	1227	555 34	2200	328 61
1947	1640	690 73	1586	466 72	1848	331 85
1948	1948	587 11	1656	481 25	2218	362 46

Females under 2 Years of Age

Year	No of Animals	With A.R Dams	No of Animals	Without A.R Dams
1944	1057	$419 23	1115	$182 42
1945	1397	453 41	1502	209 70
1946	1461	563 75	1740	214 32
1947	1573	459 95	1549	217 64
1948	1755	379 81	1782	226 95

valuable in marketing registered animals Records on their parents, and even grandparents, improve the selling price of young animals

Make a special effort to satisfy customers A satisfied customer is one of the best advertisements a breeder can have In selling animals be especially careful of the accuracy of all statements made Understate rather than overstate the desirable characteristics of an animal Mention defects that might be overlooked by a purchaser The prospective buyer will appreciate your honesty in pointing out such defects and will be more willing to deal favorably with you A sale made under misrepresentations cannot mean a satisfied customer and will react unfavorably on your business

Buying sires for artificial breeding units. The most important purchase made in merchandising cattle is a bull that is to be placed in extensive artificial service. In this case the influence of the purchase extends ultimately to a considerable segment of the cattle population, even of a state. Consequently, the person or committee responsible for choosing such an animal should proceed with extreme care and secure all of the evidence that is available

Daughter-dam comparisons can be very misleading. There is a tendency, in rating sires, to credit all of the differences between the production of the daughters of a bull and that of their dams to the genetic influence of the bull. This is not a valid assumption. Much of the difference is, or certainly may be, due to environmental influences, particularly herd differences. If the number of dam-daughter comparisons submitted as proof is small (6–10) and the variation between them is relatively great, it is unlikely that more than 20 to 25 per cent of the difference can be credited to inheritance; the remainder is probably due to environmental differences. Furthermore, early maturity in the daughters of a sire can favorably influence a sire's index, yet early maturity is not generally desirable in dairy cattle because early maturing animals do not in the main continue as desirable animals. They usually leave a herd because of weaknesses, especially udder failures, at an early age.

If a sire is put into extensive artificial service, his daughters should not only improve the yield of cattle, but they should also leave a good influence upon the soundness and longevity of the herds in which the sire is used. The daughters of a bull, if purchase of the bull is contemplated, should be studied to determine whether the bull will definitely improve the kind of cattle found in the community where he is to be used.

Plan to replenish a herd by growing young stock rather than by purchase. The purchaser of cattle is always at a disadvantage because he does not know the characteristics of the ancestry of the animals he purchases and therefore must rely upon what he can see and what he is told. There is also the ever-present danger of introducing disease and the added difficulty of getting a breeder to sell his superior animals if a herd is maintained by purchase. Herds which are replenished in this way are constantly depreciating in value, whereas herds that produce their own replacements tend to increase in value. Young stock growing to maturity enable the herd owner to cull his herd more effectively. Furthermore, more effective genetic improvement is possible through the use of better sires.

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REVIEW

1 What kind of dairy cattle should a person buy in establishing a herd?

2 What precautions should he take in bringing purchased cattle to his farm?

3 What advantages are observed in buying heifers? In buying older, outstanding though perhaps blemished animals?

4 In what type of publication can a dairyman advertise animals he wishes to sell?

5 What is a dispersal sale? A consignment sale?

6 What precautions should be taken in buying sires for artificial breeding units?

19

Factors Affecting Returns from the Dairy Farm

A person who has decided to make dairy farming his specialty should carefully consider the factors that are likely to affect the returns from his undertaking. Too many men begin farming with the thought that most farms are successfully operated and return good incomes. They fail to study the reports of farm management investigations which point out in unmistakable terms wide differences in the incomes of farmers within a community. They may continue to struggle on for many years in ignorance of methods which, if adopted on their farms, would give them much greater rewards for their efforts.

In a number of states opportunity is afforded farmers for keeping financial records of their farms in cooperation with their state colleges of agriculture. This makes possible not only a step-by-step analysis of the cost and income factors on their own farms, but also a comparison of their own records with the averages for the group. Studies of this kind help a dairy farmer to answer the question of why some farms earn more than similar farms in the same locality or in other areas.

Determining the important factors. The returns from any agricultural or business enterprise are influenced by a large number of factors. Every farmer is fully aware that his crop yields are closely related to the amount of rainfall or irrigation water supplied during the growing season. In some years his crops may be nearly a complete failure because of inadequate water while in good seasons he may have bumper crops. Less evident but fully as definite in their effect upon the success of his operations are a number of other conditions. He may remain unaware of these unless his attention is called to them. The following sections point out a few of the more important factors which a person should keep in mind before engaging in dairy farming or when seeking to improve his financial situation once he has become established in this kind of an undertaking.

Size of farm In an area in which the land is fairly uniform in productivity, there is usually a higher income from large farms than from small ones The larger farms, of course, have more acres of crops and more livestock, but there is also greater efficiency on the larger farms because of smaller "fixed" costs (such as taxes, insurance depreciation, and interest) per unit of product as the scale, or size of the business increases

The figures in Table 19 1 illustrate the differences in income from

Table 19 1 Size of Dairy Farm Greatly Affects Average Returns *

No farms	54	32	10
Size of farm, acres	136	215	300
Land area tillable, %	86	74	79
Soil rating on improved land	62	58	58
Crop acres per farm	87	121	175
Returns from			
Feed and grain	$ 7,481	$ 9,587	$13,694
All livestock	11,762	14,733	19,113
Miscellaneous	340	488	553
Total farm	$19 583	$24,808	$33,360
Cash balance per farm	$3,619	$5,301	$7,927
Net farm earnings †	$4 170	$5,617	$10,197
Rate earned on investment, %	12 3	11 9	16 4

* Mueller, A. G, Reiss F J, and Cunningham J B Summary of Farm Business Records on 2284 Farms in Illinois for 1950 Ill Farm Econ, No 195-196

† Comprises cash balance plus inventory increase and value of farm products consumed, but after deduction for unpaid labor

three groups of farms located in an intensive dairy area near a large city It will be noted that the percentage of the land area which is tillable and the soil rating, or soil productivity, are slightly higher for the smallest farms, but the differences are not wide The larger farms had more acres of crops and more livestock per farm than was the case on the smallest farms The cash balance and net farm earnings per farm were much greater for the farms having the larger acreages

Productivity of the soil Fully as important as the size of farm in terms of acres is the productivity of the soil Striking differences are found in the returns from farms engaged in the same type of production which are located in areas that differ markedly in soil productivity The figures shown in Table 19 2 represent averages of

data from farms on which cooperative farm-management accounts were kept. The average number of acres per farm in the various groups of farms was nearly the same. Likewise, the two groups of dairy farms were nearly alike in the number of tillable acres per farm, and this was also the case for the two groups of dairy-grain farms. The soil ratings (crop-producing ability) of the farms in

Table 19.2. *Average Returns from Dairy Farms Compare Favorably with Those of Other Farms* *

	Northern Illinois			South Central Illinois			
Type of Farm	Dairy	Dairy-Grain	Grain	Dairy	Dairy-Grain	Dairy-Hog	Beef-Mixed
No farms	40	30	85	43	22	28	10
Range in size, acres	180-259	180-259	180-259	180-259	Under 340	Under 340	Under 340
Average size, acres	219	226	222	213	226	221	206
Acres tillable	174	203	206	171	196	167	168
Soil rating on improved land †	64	79	85	33	41	40	35
No milk cows, ave	25	14	3	17	13	6	1
No litters farrowed	12	4	12	6	4	14	6
Net management returns	$4,364	$5,934	$6,583	$2,657	$4,286	$2,352	$1,944
Total capital invested	$78,038	$91,264	$94,640	$46,499	$52,937	$47,002	$47,474
Rate earned on investment, %	10 02	10 81	11 23	10 15	12 47	0 40	8 54
Net management returns per tillable acre	$25 08	$29 23	$31 96	$15 54	$21 87	$14 08	$11 57
Net cash income	$7,330	$7,771	$7,842	$4,419	$5,453	$3,826	$2,425
Returns to total farm ‡	$10,180	$12,190	$12,761	$7,521	$9,130	$6,891	$6,281

* Reiss, F. J, and Mueller, A G Twenty-Seventh Annual Report of the Farm Bureau Farm Management Service Coll of Agr, U of Ill, Urbana

† The agricultural rating indicates the ability of the soil type to produce the major crops grown in the region without soil treatment but with the soil drained and cleared. The scale is 1 to 100, the least productive soil being rated 1 and the most productive 100 The soil rating for a farm as determined in these studies is an estimate of the average for all of the soil types found on the improved land of the farm

‡ Returns to total farm for unpaid labor, capital, and management

the northern Illinois groups, however, were much higher than those for the south central Illinois groups Largely because of the better soils on the northern Illinois farms, a greater amount of capital was invested per farm in the northern area than in the south central area.

In comparing the two groups of dairy farms with each other and in making a comparison of the two groups of dairy-grain farms in these areas, it is evident that the northern Illinois farms had larger net management returns, greater management returns per tillable crop acre, larger cash incomes, and higher returns to the total farm than did the south central Illinois farms The northern Illinois farms had nearly as large a percentage return on the investment even

though the amount of capital invested per farm was larger on these farms than on farms in the south central Illinois groups

Kind of cattle enterprise The breeds of dairy cattle have been developed to their high state of efficiency as milk producers through many years of careful selection Breeders have sought those char-

FIG 191 Good crop yields profoundly affect the returns from dairy farms since large crop yields make possible the feeding of a large herd

acteristics which make for high and long continued production and have endeavored to perpetuate these characters through the elimination of undesirable animals Breeders of beef cattle, on the other hand have brought the beef cattle breeds to a high state of efficiency as cattle capable of producing good quality beef It is rarely possible to combine high milk yield and production of high quality beef in the same animal Dairy farmers therefore, have usually found it more profitable to keep one of the highly developed dairy breeds than one of the beef or dual purpose breeds, especially in areas where the product is sold as whole milk

The dual purpose breeds find a useful place on farms which produce large quantities of pasture forage and other unsalable roughage and where the production of milk constitutes a minor rather than a major enterprise Dual purpose cattle and beef cow herds usually

make greater use of pasture and utilize roughage as a larger proportion of the ration than is possible with high-producing dairy cows. The keeping of livestock to consume much of the roughage has a favorable influence on crop yields.

The returns from $100 worth of feed fed to beef cow herds, dairy herds, and dual-purpose herds on farms enrolled in cooperative accounting work in Illinois have been studied over a 19-year period. A brief summary of some of the figures showing the returns from the feed fed is shown in Table 19.3. It is apparent that on the farms

Table 19 3. *Kind of Cattle Enterprise as Related to Returns per* $100 *Worth of Feed Fed* *

Year	Beef Cow Herds	Dairy Cow Herds	Dual-Purpose Herds
1933	$ 90	$152	$112
1938	119	193	151
1943	108	160	118
1948	143	183	152
1951	170	187	163
19-year average	122	173	141

* Reiss, F. J., and Mueller, A. G. Twenty-Seventh Annual Report of the Farm Bureau Farm Management Service. Coll. of Agr., U. of Ill., Urbana.

studied the returns for $100 worth of feed fed was greater from the dairy herds than from the beef cow or dual-purpose herds. These figures, however, are derived solely from the value of the feed and the receipts from livestock and do not include such other costs as machinery and equipment, labor, buildings and fences, seed and crop expense, taxes, and soil fertility inputs. All of these other costs must be given due consideration before deciding upon the particular class of livestock to be kept under a given situation. Although the keeping of dairy cattle offers the possibility of good returns, a restricted supply of experienced labor, an extensive acreage, and a large supply of cheap roughage may favor the keeping of cattle other than dairy cattle.

Productive level of livestock. The quality of cattle, which in the case of dairy herds chiefly means the ability to produce milk, plays an important role in determining the returns from a cattle-livestock enterprise. An analysis of the dairy enterprise on 546 farms keeping dairy cows is shown in Table 19.4. From the total number of farms, the records of 106 high-producing farms were compared with the

records of 154 farms which had considerably lower production per cow and also lower returns per unit of feed fed The average num-

Table 19 4 Productive Level of Livestock Affects Average Returns *

Items	Dairy Cows			Dual Purpose 40 Farms
	546 Farms	108 High Farms	154 Low Farms	
No of cows in herd	15 4	1[illegible] 6	15 0	13 0
No of milk cows	14 9	1[illegible] 1	14 3	7 6
Milk cows dry %	18	17	18	26 0
Total animal units in herd	23 4	22 6	23 0	21 9
Calf crop %	100 0	103	99	110
Total weight produced	7 776	[illegible] 662	6 833	10 574
Total returns from cattle	$6 889	$7 5[illegible]8	$5 994	$4 384
Value of feed fed to cattle	$3 688	$3 189	$3 987	$[illegible] 692
Returns per $100 feed fed	$187	$237	$150	$163
Returns above feed per milk cow	$[illegible]15	$289	$140	$130
Total milk produced lb	12[illegible] 610	130 [illegible]71	111 19[illegible]	43 017
Milk per milk cow lb	8 229	8 644	7 776	5 660
Butterfat per milk cow lb	316	331	287	214
Beef per cow in herd lb	505	491	4[illegible]6	813
Death loss % of weight produced	7 9	8 0	9 3	5 1
Feed cost per unit (1000 lb milk or 100 lb beef)	$18 41	$15 39	$[illegible]2 21	$18 10
Prices received for each				
100 lb milk produced	$4 06	$4 23	$3 98	$3 45
100 lb cattle sold	$2[illegible] 10	$2[illegible] 17	$24 60	$[illegible] [illegible]
Feed per unit of milk and beef lb				
Grain	219	178	280	218
Protein and mineral feeds	52	44	[illegible]3	26
Total concentrates	271	22[illegible]	343	244
Hay and dry roughage	493	421	594	5[illegible]6
Hay silage	102	105	112	35
Corn and other silage	323	237	422	43
Pasture (pasture days)	20	18	22	28
Pasture days per animal unit	178	174	1[illegible]0	187

* Reuss F J and Mueller A. G Twenty-Seventh Annual Report of the Farm Bureau Farm Management Service Coll of Agr U of Ill. Urbana.

ber of cows per farm was nearly the same for each of the groups of farms On the 'high farms the butterfat production per cow was 331 pounds while on the low" farms it was only 287 pounds The feed cost per unit of product (1000 pounds of milk or 100 pounds of beef) was $22 21 for the low farms but on the high farms feed cost was much lower namely $15 39 per unit These differences between the two groups of farms are strikingly shown in the returns from the feed used, the high farms having an income of $87 more than that of the low farms for each $100 worth of feed fed Other things being equal the dairy herds with the higher production per unit of feed also have as a rule, lower costs other than feed per unit of product

Economy of production. A study of Table 19.5 reveals wide differences in the returns from milk cows of different levels of pro-

Table 19.5. *Returns over Feed Cost Mount as Production Rises* *

Yearly Butterfat Production per Cow: Range, lb.	Ave., lb.	No. of Records	Roughage	Grain	Total	Value of Product over Feed Cost †
125–174	156	725	$61	$ 56	$117	$ 39
175–224	204	2272	65	67	132	72
225–274	253	5092	68	74	142	111
275–324	301	8269	71	81	152	149
325–374	350	9807	73	88	161	189
375–424	399	8724	75	94	169	230
425–474	448	5779	77	101	178	270
475–524	496	3247	79	108	187	309
525–574	546	1512	82	118	200	346

* Dairy Herd Improvement Association Letter, U S D.A., *28*, No. 9.
† Value of butterfat calculated at $1 per pound (approximately $4.10 per cwt. of milk).

ductivity. The value of the product over feed cost of cows producing from 175 to 224 pounds of butterfat yearly, which is the approximate average production of all milk cows in the country, was only $72, while the returns over feed cost of cows producing twice as much, that is, from 375 to 424 pounds of butterfat per cow, was more than

Fig 19.2 The keeping of high-producing cows is one of the most important factors affecting the returns from a dairy farm.

three times as great As the productive level increased, the value of the product over feed cost increased much faster than did feed cost How can this apparent discrepancy be explained?

These differences in returns are the sum total of a number of influences First, a cow's milk-producing capacity is determined chiefly by inheritance, but it is also influenced by the kind of feed and care she receives The figures in Table 19 5 show actual records of cows kept by operators who were attempting to obtain high net returns from the dairy enterprise Undoubtedly some cows in these herds were incapable of producing large amounts of milk Others were not fed and cared for up to their capacity to produce

Suppose a person plans to undertake the management of a dairy herd In purchasing new female stock, in selecting heifers to be raised for herd replacements, and in choosing herd sires, should he strive to have a herd capable of the highest practicable production level or should he assume that moderate production per cow is most profitable because of lower feed and labor costs? An understanding of the principle of the economy of high production often helps to answer questions such as this and also furnishes a sound basis for the day-to day management of the herd This is one of the most important principles of milk production

Three factors bearing on the economy of production are explained here The first two deal with the utilization of feed by the dairy cow and show the savings and advantages which are possible through the principle of the economy of high production

1 The amount of feed required to maintain a cow, that is, to keep her at constant weight and in good health, remains practically the same if she is dry or if she is producing milk, provided there is no change in her live weight Feed needed for maintenance is in direct proportion to live weight at all times

2 After sufficient feed to meet the maintenance needs of a cow has been supplied, the amount of feed required to produce a pound of milk of a given butterfat content is practically the same regardless of the level of milk yield Let us assume that the cow's maintenance needs (when she is dry, non pregnant, and not gaining in weight) are met by feeding her 15 pounds of grass-legume hay To supply nutrients for milk production grain mixture is fed in addition to the feed needed for maintenance at the rate of 1 pound of grain mixture for each 3 pounds of milk For the daily production of 15 pounds of milk, therefore 5 pounds of grain mixture is fed in addition to the feed supplied for maintenance The total feed, then,

is 20 pounds. For 30 pounds of milk daily, 10 pounds of grain mixture in addition to the maintenance feed must be given. Putting these figures into table form, in which all of the values are given on a pound basis, makes it clear that with rising daily production of milk, larger amounts of milk are obtained from each unit of total feed supplied. The amounts of feed mentioned in this illustration

Daily Milk Yield	Feed for Maintenance	Feed for Milk	Total Feed	Milk per Pound of Total Feed
0	15	0	15	0
15	15	5	20	0.75
30	15	10	25	1.20
45	15	15	30	1.50
60	15	20	35	1.71

are in part theoretical because, as explained in Chapter 8, efforts are made in the feeding of high-producing cows to have them consume larger amounts of roughage and less grain than are here indicated. Further, the milk-yielding capacity of a cow is determined largely by inheritance. Some cows are not capable of responding to increased grain feeding. In the case of all cows, a point is finally reached where additional increments of feed fail to bring corresponding increases in production and finally no increase at all.

3. The principle of economy of high production may be extended to include costs other than feed. The most important of these other costs is labor; but housing, interest, taxes, insurance, depreciation, veterinary fees, equipment, and breeding costs are also included. A high-producing cow requires but little more labor or barn space than a low-producing one. Depreciation, interest, taxes, insurance, etc., are somewhat greater for high-producing cows. For cows of different levels of production these other costs increase less rapidly than production, and it follows, therefore, that they become less for each unit of product as production per cow is increased.

The conclusion from the explanation of the three factors which have been given above may now be summed up and stated in the form of a definition, as follows:

The economy of high production as it applies to dairy cows means that the greater the yield of product by an individual cow (within the limitations explained above), the lower is the cost of production for *each unit* of product.

The principles explained in the preceding paragraphs hold good under practically all conditions so far as the use of feed nutrients

and overhead costs are concerned but this does not imply that a dairy farmer at all times should strive for high milk yields per cow. As a rule high production per cow means the feeding of considerable quantities of grain mixture. On most farms more pounds of total digestible nutrients can be obtained per acre from roughages than from grains. Hence (1) when feed prices are high in relation to milk prices, (2) when the amount of labor is limited or the labor cost excessive, or (3) when extensive grassland farming is best because of

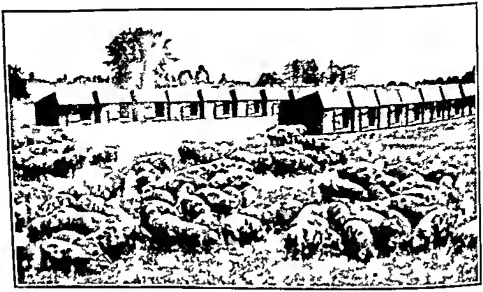

Fig 19 3 A diversity of enterprises on the dairy farm may bring greater returns than a single enterprise (Photo J C Allen and Son)

the need for soil conservation, it is possible that the most profitable overall farm plan may be found in a high roughage utilization program under which cows produce only at moderate levels of milk yield (compare Chapters 8 and 23).

Diversity of enterprises Dependence upon a single enterprise which brings the only cash income to the farm usually is attended with more risk than is reliance upon two or more enterprises, provided, of course, the manager has the ability and labor supply at his command to carry on a diversity of enterprises in a capable manner. In the comparison of the return from dairy farms and other types of farms shown in Table 19 2, it is evident that the keeping of dairy cattle was not the only livestock enterprise on these farms. Receipts from the sale of hogs formed a considerable part of the cash income. Since most of the farms produced grain crops as well as forage crops, the feeding of part of the grain to hogs instead of selling the grain

undoubtedly was an aid to soil conservation and had a beneficial effect upon crop yield.

Cropping system. Since the transportation of hay and other roughages is usually expensive on account of their bulky nature or impracticable because of their perishable qualities, as in the case of pasture forage and silage, dairy farmers in most instances plan to

Table 19.6. *Crops Differ Widely in Yield of Nutrients*

	Yield per Acre *	Digestible Protein per Acre, lb.	Total Digestible Nutrients per Acre, lb.
Grains and Seeds			
Barley	24.2 bu.	116	883
Corn	32.9 bu.	130	1426
Oats	32.8 bu.	94	777
Rye	12 0 bu.	60	537
Soybeans	18.8 bu.	395	1049
Wheat	17.0 bu.	101	829
Roughages			
Alfalfa hay	2.20 tons	528	2376
Clover and timothy hay	1.36 tons	218	1387
Corn silage	8.24 tons †	165	2802
Lespedeza hay	1.06 tons	254	1145
Sorghum silage	5.85 tons	117	1872
Soybean hay	1.30 tons	286	1378
Wild hay	0.89 ton	18	890

* Average yields for the U. S., for the 10-year period 1939–1948 as reported by Crops and Markets, U.S.D A.

† Average yields for the six-year period 1946–1950 as reported by Crops and Markets, U.S.D.A.

grow on their farms all or nearly all of the roughage required for the feeding of their cattle. Since grain is also used extensively in the feeding of the dairy herd, much grain is produced on dairy farms which are located in areas where such a farm program is practicable. About one-half of the milk cows of the United States are located in the north central states and this region is also the principal feed-grain producing section of the country.

Since the feeding value of a crop is reckoned in terms of its total digestible nutrient content (Chapter 10) rather than in terms of bushels or tons, progressive dairy farmers use much care in the choice of crops and adopt cropping systems which give a large yield of total digestible nutrients to the acre. A 33-bushel crop of corn supplies approximately twice as many pounds of total digestible nutrients as does a 33-bushel crop of oats (Table 19.6). Alfalfa gives a high

yield of hay per acre and principally because of differences in yield, the amount of total digestible nutrients in a crop of alfalfa hay is about twice as great as the amount in other commonly grown hay crops The high protein content of the legume hay crops makes them especially desirable for a dairy farm These facts explain the emphasis which capable dairy farmers place upon cropping systems in which legumes are grown for hay or silage and also why the main forage crops on some farms are alfalfa for hay and corn for silage

Crop yields The yields of corn whether it be used as only a roughage crop or for both roughage and grain, are fully as important on dairy farms as on other types of farms Obtaining larger yields of crops than were formerly grown is one method of increasing the intensity and efficiency of the enterprise The higher crop yields make possible the keeping of more livestock than the farm formerly supported and increase the possibilities for larger returns Increasing the numbers of productive livestock, such as dairy cows, is often as advantageous as increasing the number of acres in the farm It is essential, therefore, that the operator of a dairy farm be a capable farmer from the standpoint of crop production as well as being a good caretaker of dairy cattle It is only through painstaking and constant attention to all the factors which affect the welfare of the livestock and the yields of the crops that maximum production may be achieved

Market prices Selling livestock and farm crops at times when prices are most favorable and choosing the most profitable kind of milk market are management procedures which may have fully as great an effect upon farm returns as do some of the other factors discussed above Market prices of livestock, farm crops, feeds, protein supplements, and fertilizers normally change from day to day, unless such prices are under governmental stabilization programs Some products sold or bought by farmers have definite seasonal patterns which may be used as a basis for making decisions on when to buy or sell and whether or not to organize production on a seasonal basis

The dairy farmer as an individual has little control over market prices He can, however, often obtain better prices by joining a cooperative marketing organization than by marketing his products independently Because the prices for any one product may be unfavorable in some seasons a dairy farmer may protect himself in part against such a situation by engaging in a diversity of enterprises, rather than in a single milk-production enterprise

Operator's ability. The foregoing discussion of the returns from dairy farms as affected by various factors is based upon the averages of groups of farms. The differences between groups are pronounced. May one infer from the discussion and the accompanying tables that every farmer within a particular group obtained returns as large as the group average?

While group averages are of great value in showing trends and in drawing conclusions concerning the value of particular systems of farming and certain farm practices, they by no means picture the wide spread in returns made by individual farmers or the possibilities of higher than average incomes which are open to farm operators of superior ability. Over a period of years, the returns from the dairy cattle enterprise are a reflection of the competence and skill of the operator. The highly capable operator buys or raises dairy cattle of high productive capacity and feeds and manages them in such a manner that the returns are larger than those from poorly managed herds. The returns per $100 worth of feed fed form a good index of managerial ability. The figures in Table 19.7 show the distribution of the returns from dairy cattle enterprises in Illinois over a 4-year period. The returns ranged from under $100 to more than $260 for each $100 worth of feed fed. It is evident that a few of

Table 19.7. Frequency Distribution of Returns per $100 Worth of Feed Fed to Dairy Herds *

Returns per $100 Feed Fed	Per Cent of Herds			
	1951	1950	1949	1948
Under $100	1	1	4	10
100–119	4	6	4	7
120–139	8	14	11	9
140–159	12	16	18	12
160–179	15	19	18	15
180–199	19	17	19	12
200–219	14	12	13	10
220–239	11	7	6	7
240–259	6	2	4	6
260 or more	10	6	3	12
	100	100	100	100

* Reiss, F. J., and Mueller, A. G. Annual Reports of the Farm Bureau Farm Management Service. Coll. of Agr., U. of Ill., Urbana.

the herds gave returns much below the group average while some 6 or 7 per cent of the herds made returns far above the average

The part which the farm operator plays in the management of the farm is strikingly shown by the earnings of tenant operators During a recent 4-year period, tenants on farms engaged in cooperative farm management investigations made annual earnings ranging from a loss (not enough to pay expenses) to more than $14,000 per tenant The farms ranged in size from 150 to 250 acres and were located on the best soils (rated 75 to 100 in productive capacity)

Although all phases of farm operation can be carefully analyzed and many important factors affecting the returns can be measured, such studies clearly point to the competency with which the farm is managed as the factor of greatest consequence This brings to mind the old saying, the eye of the master fattens the cattle" Truly, dairy farming affords a challenge and a worth-while opportunity to the well-trained and competent operator

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REVIEW

1 How can one discover the factors which have an important influence upon his farm earnings?

2 How does size of the dairy farm affect returns?

3 Explain the relation of soil productivity to farm income What is meant by soil rating?

4 What class of cattle usually brings highest returns for $100 worth of feed fed? Explain

5 How does the productive level of livestock affect returns which are received from the livestock enterprise?

6 What is meant by the economy of production of dairy cows? Discuss three of the factors which help to explain this efficiency

7 Discuss the effects of (1) diversity of enterprises (2) cropping system and (3) crop yields on the returns from a dairy farm

8 Discuss the effect of taking advantage of good markets on the returns from a dairy farm

9 Is the ability of the dairy farm operator reflected in the farm earnings? Explain fully and illustrate

20

The Mammary System, Milk Secretion, and Milking

The dairy industry is based upon the procurement, processing, and merchandising of the product of the mammary gland of the cow If this portion of the anatomy of the cow can supply an entire national and even international dairy industry with all of its raw product, then we should find this a sufficient incentive to learn a great deal about it

Mammals vary greatly in the size shape, structure, capacity, and milk removal mechanism of this gland At one end of the evolutionary scale are the monotremes who secrete a milk-like substance in crude abdominal glands and whose young obtain the secretion by licking coarse hairs At the other extreme is the highly developed cow from whose udder man has succeeded in removing more than 21 tons of milk in a single year Add to this the high nutritional and biological value of the product of the gland, which was referred to in Chapter 1, and it is not difficult to appreciate that a cow s udder is highly important to a great industry and even to the welfare of the peoples of the world

The mammary system The entire mammary system in the cow consists of an udder, the organ of milk secretion, the teats, which are designed to remove the product of secretion (milk), the arteries which are largely responsible for the input of nutrient materials, and the veins which handle most of the by-products output of the mammary system A dairyman would probably include only the udder, teats and external milk veins when speaking of this system

The make-up of the udder. The udder of the cow is composed of four more or less separately identifiable compartments or glands These four glands are not entirely separate For example, there is a rather free interchange of blood, both arterial and venous, between the front and rear quarters of each half of the udder There is less, but some exchange of blood between the two halves of the udder This latter has been fully demonstrated by vinyl-acetate injections

of both the circulation and udder. In this experiment, conducted by one of the authors, the tissues were digested away after injection, leaving in clear relief the course of the arteries and less clearly the venous system. Figure 20.1 shows the milk removal structure of the gland of a cow milking approximately 50 pounds of milk daily.

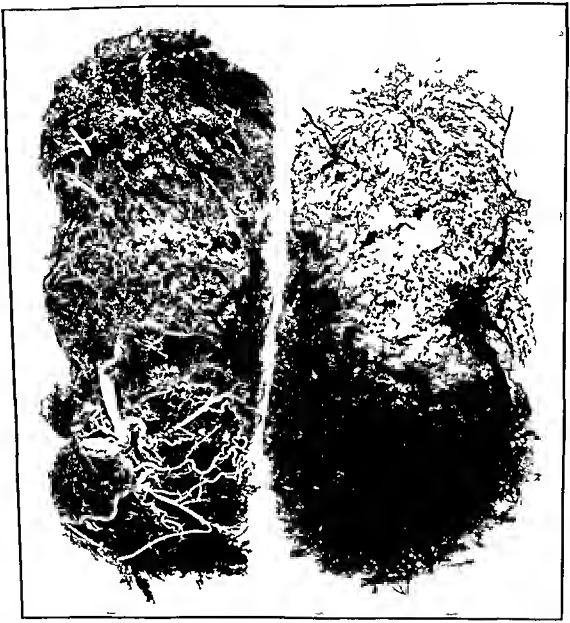


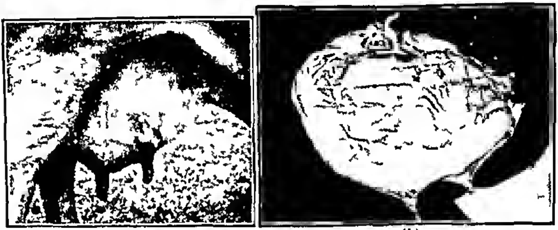
Fig. 20.1 The milk removal system of a cow's udder. By injecting vinyl acetate into each quarter of an udder immediately after its removal from a slaughtered cow and then dissolving away all of the tissues with concentrated hydrochloric acid, the intricate system for storing and removing milk is revealed. The light and dark areas to the right are front and rear quarters respectively. The light artery at the left is the pudic artery. The picture looks down on the top of the udder. The teats are below and are not visible.

at time of slaughter The technique used was to inject the quarters of the udder with vinyl acetate, fix the material, and then digest away the tissue The vinyl acetate alone remained after digestion By injecting the arteries and veins with a different color of the same material it was easy to distinguish between the circulatory and milk removal systems

The principal support of the udder is the median suspensory ligament This ligament sends out fibers along the abdominal wall directly above the center of the udder This plate of fibers serves as an anchor for the thicker fibrous material which forms on a median line directly above the center of the udder and extends downward in fan-like fashion on the inside and between the two halves of the udder, thus providing a firm support In heavy-milking cows, the strain on this ligament, especially just before calving, is terrific If for any reason this main support fails, then the center or sole of the udder drops down and the teats point outward instead of directly downward as they should If this condition occurs it is deemed to be a serious defect, and usually it grows worse after each successive calving Figure 3 4 shows the median suspensory ligament after it has been dissected away from its abdominal support The legend beneath the figure describes the case

The morphology or form of the udder. There are wide differences in the forms or shapes of cows' udders Some of the udder types display weaknesses of such a nature that they interfere with the normal and continued function of the glands In Chapter 3, page 38, we discussed some of the defects that reduce milk yield In general, udders of good texture that are held snugly to the body of the cow and that are not too large in size are less subject to injury and therefore more highly regarded by good dairymen Large, meaty udders (poor in texture) that hang low and swing back and forth as the animal walks are more subject to injury and more susceptible to mastitis Furthermore, such udders are difficult to milk and require more time for milking than the well-formed udder In the normal udder the rear quarters produce a greater proportion of the milk. The ratio is approximately 60 per cent for the rear to 40 per cent for the front quarters of the udder The two halves (right and left) are essentially equal in secreting ability, each producing one-half of the milk Individual cows deviate widely from these values Such departures from the normal may be accounted for by heritable differences, injury, mastitis, or long-continued poor management, especially in milking

Occasionally, there are meristic[1] deviations. Heizer describes a cow with two quarters and two teats on the right side of her udder and one quarter and a single teat on the left side. Erizan reports having observed three Armenian cows with two teats only. One of the authors has studied a case in which the cow had a normal full-sized udder but discharged all of her milk through the two rear teats. In this cow the four teats appeared normal, but there were no openings in the front teats. During each of the three successive lactations



(a) (b)

FIG 20 2 The udder of this cow appeared to be normal except that all of the milk was discharged through the two rear teats (a) The udder and veins (b) A section of the udder infiltrated with a dye proves that it was a full sized udder but that it discharged all of the milk through the two rear quarters

she yielded in excess of 500 pounds of butterfat, making it obvious that her udder had a capacity equal to that of a normal, four-quartered cow. Figure 20 2 shows a transverse section of this udder which indicates that all of the milk was discharged through the rear teats. For comparison, Figure 20 3 shows a normal four-quartered udder, prepared in a similar manner, from a cow essentially of the same age and of the same breed.

Structure of the interior of a cow's udder. The following steps are essential in milk secretion and in its removal from the udder by the act of milking. (1) Entrance into the udder of the materials from which milk is to be made. (2) The change from the raw materials received in the udder to the substance, milk. (3) Storage of the accumulated milk until time of removal. (4) Ejection of the milk

[1] Meristic variation refers to differences in the number of parts, for example, the number of quarters to an udder or the number of teats on a cow

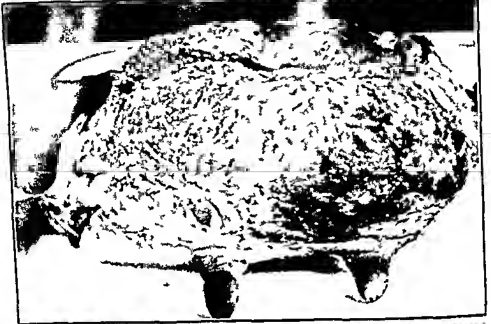


Fig. 203. This udder from a normal cow was prepared by using two different colors of latex rubber in the front and rear quarters. Compare with the udder shown in 202b above.

in the milking process. (5) Removal from the udder of the by-products of milk secretion other than milk itself. It requires an intricate structure in the udder to accomplish these five things.

The blood is the principal vehicle that conveys nutrients and oxygen to the udder and that removes the by-products and waste materials, including carbon dioxide produced, from the udder. The blood propelled by the heart flows under considerable pressure through the right and left external pudic arteries into the right and left halves of the udder respectively. Almost at point of entry into the udder this large pudic artery branches into smaller mammary arteries and through these the blood reaches the capillaries found in all parts of the udder. After the arterial blood reaches the cells in which the process of milk secretion takes place it is picked up by minute veins and through ever larger mammary veins reaches, or a considerable part of it reaches, the external pudic vein and finally returns to the heart. An alternate venous system, the one most often spoken of in judging, involves the large abdominal vein referred to as the milk vein and through it a portion of the blood also finds its way back to the heart.

The lymphatic system plays a small part in conveying materials into and from the udder This circulatory system is not a pressure system and therefore is very sluggish in its action Fluids travel in this system by means of a series of valves which prevent return flow Movement of tissues, pressure, etc , are the propelling agents in this system Just prior to calving the lymphatic system is often inadequate to remove the accumulated lymph rapidly enough and an edemic condition in the udder often results

The blood supplied to the udder in a heavy-milking cow, one that is yielding from 60 to 100 pounds of milk daily, is enormous Petersen and others have estimated that it requires a flow of from 300 to 400 volumes of blood through the udder for each volume of milk produced

Milk secretion done by cells The responsibility for the elaboration or secretion of milk is put upon a vast army of epithelial cells all located within the udder Each minute cell, when the cow is lactating (milking), becomes a diminutive factory for milk production The epithelial cells are arranged around a tiny alveolus A number of these alveoli form lobules very much as grapes form around a central stem Several lobules form a lobe, and each lobe is drained by a single duct which combines with other larger ducts and finally the milk reaches at some stage of the milking process, the cistern of the gland which is located directly above the teat During the time that milk is accumulating between milkings, and especially just before milking the entire milk removal system of tubules ducts, and cisterns is gorged with milk In the show ring this accumulation of milk in the udder is known as ' bagging up

This bagging up process creates pressure in the udder which sometimes reaches as much as 30–40 mm of mercury Tests on different lactating cows and at different stages of lactation show a good deal of variance in the amount of pressure that will build up when milk is accumulated in the udder At some point perhaps at approximately 40 mm of mercury pressure milk secretion stops Unless the pressure is removed resorption begins Resorption is usually complete in 10 to 14 days after which the udder gives the impression of a normal dry udder

Proliferation a precursor to lactation Under normal management a cow should be permitted to remain dry for a period of from 4 to 8 weeks prior to calving During the last 2 to 3 weeks of that period her udder begins to enlarge, often becoming swollen and feverish and frequently highly congested After parturition (calving), and when

lactation begins, the congestion and swelling gradually disappear This condition is associated with calving and is a preparation for lactation The term proliferation refers to the very rapid growth of the milk secretion and milk removal structure for that lactation The completeness of proliferation within the udder bears a relation to the productive level for the lactation Figure 20 4 shows three stages of the udder of the same cow Figures 20 4a and 20 4b show the udder completely dry and before proliferation begins Figures 20 4c and 20 4d indicate the proliferation stage well advanced The photos were taken 3 days prior to calving Figures 20 4e and 20 4f show the cow in full flow of milk These exposures were made approximately 2 hours before milking

After a cow reaches her peak of production, which usually occurs at some time between the third and eighth week after calving, daily milk production gradually declines The rate of decline varies in different cows and under different environments If the rate of decline is slow the animal is said to be persistent in production, if very rapid the cow lacks this quality The lactation yield of any cow is determined by the maximum daily yield and the rate of decline from that maximum level of production

In the gland itself, evidence appears to indicate that the epithelial cells at the top or next to the body of the cow cease to function first This tendency continues in a downward direction until finally all of the secreting cells cease to elaborate milk and the animal goes dry

The color plates between pages 286 and 287 illustrate the result of some research currently being conducted by one of the authors in the laboratories of the Dairy Science Department, University of Illinois These colored photographs portray the milk removal mechanism of three different dairy cows that were yielding at time of slaughter widely different amounts of milk

These reproductions are the product of injecting at a pressure of approximately 40 mm of mercury, vinyl acetate into each quarter of the empty udder of the cow immediately after it was removed at time of slaughter The injected udder was then immersed in cold water for from 24–48 hours The water was then removed and the tissues were digested away by the action of concentrated hydrochloric acid (HCl)

The vinyl acetate having been solidified by the water fixing process is not affected by the acid and therefore retains the shape of the tubes and tubules into which it was forced while it was in liquid form Thus the milk removal and milk storage mechanism

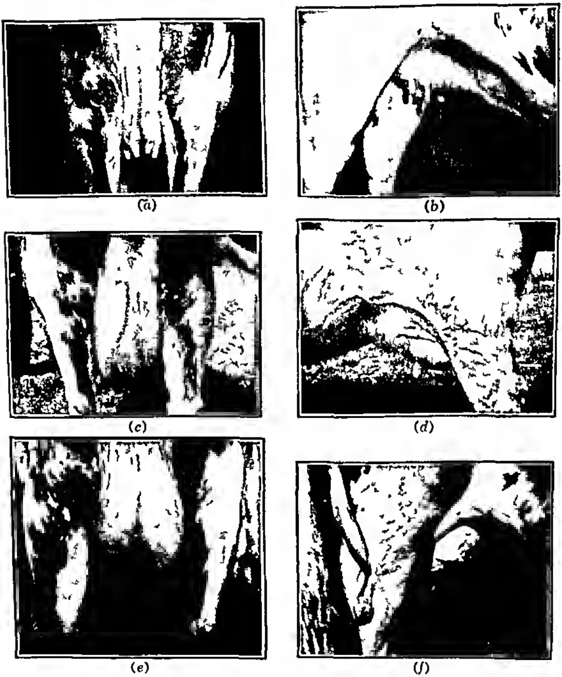


FIG. 204. Three stages in the milk production cycle of the same cow. *a* and *b* show the cow dry, *c* and *d* making up preparatory to calving, *e* and *f* in the next lactation. This cow has an excellent udder.

of the udder is preserved as a solid, whereas it previously existed as a highly complicated system of voids

The cow whose udder is illustrated in (*a*) was milking 32 pounds daily when slaughtered The yellow and red areas, on the right half, represent the right front and right rear quarters, respectively The external pudic arteries on the left and right sides respectively were injected with yellow and blue vinyl acetate

The reproductions (*b* and *c*) show the ventral and dorsal (bottom and top) portions of the same injected udder

The cow (*b* and *c*) was milking 55 pounds daily when slaughtered The milk vein on the left side of the udder was injected with yellow, the artery with red

The cow in (*d*), although a good milker, was almost dry and milking only 2 to 3 pounds daily when slaughtered This udder, except for a very small area above each teat had ceased to elaborate milk

Mammary tissue appears to differ from most other tissues in that it has the property of changing its form It can proliferate, thereby establishing an intricate network of cells and tubes that comprise the lactating udder, which in this stage can secrete milk at full capacity Then gradually a metamorphosis takes place, and section by section the lactating areas change to resting areas, until finally, when the cow is dry, almost the entire gland takes this form This process is repeated with each lactation

Milk secretion is largely controlled by hormone influence In all mammalian forms, nature intended the product of the mammary gland to nourish the non-precocious young Therefore, reproduction and milk production are closely bound together The following vital processes are accordingly all very closely associated (1) growth, (2) sexual maturity, (3) ovulation (4) fertilization, (5) gestation (6) parturition, and (7) lactation Aside from growth and sexual maturity, the remaining processes of the cycles are repeated with each new lactation

In the cow the function of the ovary is indispensable to ovulation which is the starting point of the reproduction cycles A number of hormones have a part in ovarian behavior The stimulating hormone of the follicle prepares the area of the ovary that is to produce and liberate the ovum (female reproductive cell) The release of estrogen into the blood stream creates the desire of the female to mate (oestrus) The LH or luteinizing hormone ruptures the ovarian follicle and releases the ovum into the Fallopian tube where it is

(b) (a)

(d)

(c)

usually fertilized. Another hormone produces the corpus luteum; still another causes the developing embryo to be carried to term.

The mammary gland develops largely because of the hormones estrogen and progesterone. It secretes milk largely because of the presence of a lactogenic hormone. Milk secretion is sustained throughout the lactation because of the presence of this hormone. After the fifth month of gestation, pregnancy has a depressing effect upon lactation. It is probable that this is caused by some inhibiting influence of hormone origin or a diversion of the nutrients of the blood to the developing fetus or both.

The source of many of the hormones referred to above and of another, oxytocin, which is associated with milk "let down," is a very small gland located at the base of the brain and known as the pituitary gland. This small gland has two lobes or parts. The lobe farthest forward is called anterior, and it is the more important of the two in producing hormones to control growth, lactation, and many other body processes.

The milking process is largely controlled by the "let down" hormone, oxytocin. One of the most important single factors in sustaining lactation (holding up daily milk yield) is the regular, periodic, and complete removal of milk from an udder. The process of milk removal involving (1) the number of milkings per day and (2) the complete removal of milk at each milking is highly important in determining the annual yield of the cow.

By a rather ingenious series of experiments, Petersen et al.[1] demonstrated that the hormone oxytocin more or less controlled the milking process. It had been known by dairymen for a long period of time that if a cow was disturbed or frightened she could not be successfully or completely milked. In such cases the dairymen referred to this condition as "holding up" the milk. Petersen was of the opinion that the cow did not consciously or intentionally "hold up" her milk but rather that she could not, for some reason, "let down" her milk when in a disturbed condition. Petersen and his co-workers, therefore, set up certain experiments to ascertain the role of hormones in milk "let down" or milk release. In essence their experiments were designed to get the cow into a disturbed condition and then try various procedures for milking her. Accordingly, such tactics as putting a kitten on the back of the cow, breaking a paper bag in front of

[1] Ely and Petersen, J. Dairy Sci., 24:211, 1941. Miller and Petersen, J. Dairy Sci., 24:225, 1941.

her, or sticking her with a pin were used to frighten or disturb the animal. They found that when the cow had been agitated in this manner they were unsuccessful in obtaining any appreciable amount of milk even though milking was carefully done.

If, however, oxytocin was injected directly into the artery (external pudic) that supplied blood to the right half of the udder, the milker almost immediately began to get the expected amount of milk from that half but the left half still did not release the milk. In approximately 50-60 seconds after injection (the time required for the return flow of blood), the left half also began to release milk in the normal manner. Thus was demonstrated a basic principle, namely, that the hormone oxytocin was definitely associated with the milking process.

Punctuality and regularity are important factors in milking. Dairy cows are creatures of habit. If milking and feeding times are customarily at 5:00 A.M. and 5:00 P.M., the cows expect to be milked and fed at those times. If the operator does not appear within a few minutes of the regular hour, the cows become disturbed and thrash about in their stanchions. Under such conditions cows do not respond as well at the pail as they normally do when milked at the regular time. Certain barn operations, especially those that involve milking, should, therefore, be carried out at the same time each day and, if possible, in the same manner and by the same persons. The cow responding to these habits of management is prepared to do her part at time of milking. For example, when the pails rattle she expects to be fed, when her udder is washed she looks forward to being milked, etc. If you will observe the udder of a cow after she has been prepared for milking you will note that the teats are well filled and possibly dripping milk. She should be milked immediately because the hormone oxytocin has been released into the blood stream and milk removal is readily achieved.

Milking should be quickly and completely done. The effect of the hormone oxytocin when released into the blood stream of the cow is temporary in nature. The major influence continues for a period of from 5 to 8 minutes. Milking and stripping should, therefore, be completed before the influence of the milk-release hormone wears off. Cows do differ in the speed with which they can be milked.

In some studies on systems of milking made recently at the University of Illinois, it was demonstrated that some cows required as much as 8 minutes to completely remove their milk, whereas the great majority of the cows could be milked in from 2½ to 5 minutes

The slow milkers usually either had small teat openings (teat meatus) or very strong sphincter muscles Very rarely are cows incapable of producing or limited in their capacity to produce oxytocin. However, if this failure should occur, they will yield very little milk, or appreciably less than the expected amount. In such cases oxytocin administered before each milking has corrected this condition and markedly increased the annual yield of milk.

If milking is not thoroughly and completely done, milk secretion diminishes and the cows tend to go dry. This may be true also for a single quarter of the udder. One of the authors noticed that three cows in his herd were very deficient in the left rear quarter. A yield check showed that the left rear quarter of each of these cows was producing only one-third as much milk as the right rear quarter. The cows had normal rear udders when they had calved for that lactation and none had had mastitis

A management check showed that these three cows were hand-milked by the same individual. The milker was a portly person who used a high stool and therefore found it difficult to reach the left rear quarter. Consequently, that quarter was never milked dry. The milker was changed but the quarters never returned to normal production during that lactation. After calving in the next lactation, the deficient quarters returned to normal and remained so during the time those cows were in the herd

Systems of milking. There is considerable difference in the manner in which milking is done. In almost all commercial dairies and even in many small herds, milking is done by machine. Except in the case of a few purebred cows that are making large Herd Improvement or Advanced Registry records or in very small herds where an investment in a milking machine is not justified, hand-milking is no longer done. It should be mentioned, however, that good hand-milking is probably the best method for removing the milk from a cow.

Conventional stanchion barn milking installations. Most of the milking is done when cows are restrained in stanchions in a conventional barn In such installations an operator usually uses two milking units and an extra pail. Stripping is done either by hand or by machine The trend is toward machine-stripping. If additional units are used, the total time for milking is less, but machines remain on the cow for a longer period Table 20.1 gives the result of time-motion studies made at the University of Illinois when a man and his helper operated two units and four units in milking a selected

Table 20 1 Average Time Required for Operations Performed in the Milking of 24 Cows

Work Accomplished	Operation Time, ave min per cow * 2 Units	4 Units
Operator		
1 Prepare cow	0 42	0 47
2 Rinse and attach units	0 20	0 18
3 Place cups on cow	0 20	0 21
4 Machine strip	1 27	0 84
5 Move cart from cow to cow	0 06	0 03
6 Replace head on pail	0 18	0 17
Helper		
1 Pour milk	0 17	0 17
2 Carry milk	0 20	0 12
3 Weigh and sample	0 34	0 41
4 Strain milk	0 11	0 10
5 Return from milk room	0 23	0 15
6 Idle	1 30	0 70
Total operator and helper	4 68	3 55
Ave time machine on cow	4 56	7 25

* Two trials 24 cows each Presented at the 48th Annual Meeting of the American Dairy Science Association Madison Wis, June 22-24, 1953

group of 24 cows In this case the work accomplished by the machine operator and his helper is separately indicated It was deemed impractical for one man to attempt to operate four milking machine units in a stanchion barn installation

Separate milking quarters and milking parlors Separate quarters are required for milking if the dairy cows are kept under a loose-housing system The loafing barn, resting shed, or loose-housing system are terms used to indicate the open-shed type of housing, more fully discussed in Chapter 27, which permits cows to move freely within the enclosure A survey made in Illinois in 1952 and reported in "A Year's Progress in Dairy Herd Improvement" showed that 19 per cent of the D H I A members (1542 herds) used loafing barns and 13 per cent had milking parlors The cows may or may not be fed roughage in the loafing barn Usually the best arrangement provides an area for the feeding of roughage that can be cleaned more easily and more frequently than the main enclosure Cleanliness and sanitation under this system are discussed more fully in Chapter 22 Separate milking quarters are usually one or the other of two types

Perhaps the more common consists of a separate building in which conventional milking machines are used. The cows under this arrangement are milked and fed grain in this building. The number of stalls depends somewhat upon the size of herd but usually varies from four to ten. The milk is generally poured into cans and conveyed to the milk house, which may or may not be a part of the building that includes the milking quarters.

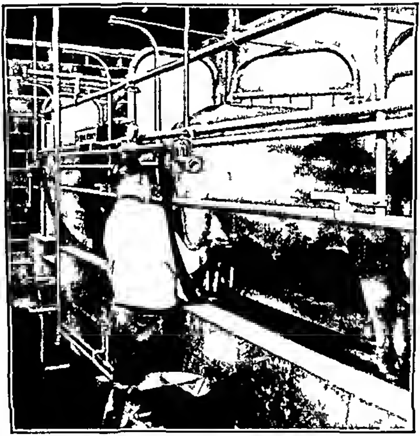


Fig. 20.5. A modern milking parlor showing a two unit operation. Milking parlors of this type have the advantage of sanitation and take some of the wearisome toil away from milking.

The true 'milking parlor' is somewhat more elaborate. It is designed so that the cows are on an elevated platform and the operator who stands in a pit or well can place the teat cups on the udder of a cow without stooping. A sanitary vacuum pipeline conveys the milk from the receptacle in which it is milked and weighed to the can or tank where it is stored and cooled. Figure 20.5 shows such an installation in operation. There is often a separate preparation room in which the cows first go to have their udders washed preparatory to milking. After being milked the cows are returned to their stan-

chions or loafing quarters The more elaborate installations of this type are relatively expensive but do have an advertising value, especially if milk is being produced for a special trade

Pipeline milker installations. Within the past few years a new concept of milking has been developed Long lines of permanent sanitary piping, usually glass or stainless steel, are installed, often in a regular stanchion barn This line is washed while in position and not taken down for cleaning Milking is done by conventional units and the milk is conveyed directly by vacuum to a cold-walled cooler Milk of excellent quality can be produced by this system of

FIG 206 Pipeline milker installation at the University of Illinois The overhead track with the milk scale attached to a pulley makes it possible to weigh the milk of each cow without losing the labor-saving advantages of the pipeline system The pipeline installed *above is glass*, the one below it is stainless steel. They are both equally effective

milking. Figure 20.6 shows an installation of this type at the University of Illinois. Chapter 27 discusses the results obtained while using this milking system in the production of milk of good quality.

Essentials of a good milkiag program. No matter what system is used in milking there are certain essentials that must be observed in a good milking program.

Cows should be treated kindly. Every effort should be made to avoid getting the cows excited or frightened before or during the milking process. Cows that are in this state cannot "let down" their milk normally or completely. The dairyman, therefore, loses some milk at the time, and as a rule the cows because of this tend to secrete less milk in subsequent milkings. They might yield above normal at the next milking but the extra milk is residual milk not completely removed when it should have been.

Cows should be prepared for milking. Perhaps this is best accomplished by washing the udder in warm water to which a small amount of a chlorine disinfectant has been added. Use of the strip cup and some added massage at this time have value. Start milking when the udder and teats indicate that the milk has been "let down" into the teats.

Milking should be done properly and quickly. Milking machines ought always to be kept in good order and teat cups should be properly adjusted. The operator should watch the milking operation and begin machine-stripping as soon as the teat inflations tead to creep up on the teats. When milk secretion drops to 0.1 of a pound of milk in 10–15 seconds, the machines should be removed. If hand-stripping is used the machines should be removed when the flow in the line ceases. An experienced milker should be left to his own discretion in removing the teat cup from the udder.

Mastitis cows should be milked last. One of the most important considerations in milking is to prevent the spread of disease. Infected milking machines constitute one hazard to udder contamination. It is, therefore, a worth-while precaution to milk the healthy cows first, and then to milk any cows that have any infection or that react to tests for mastitis. Immediately after milking the infected cows, all milking machine parts should be thoroughly washed and disinfected.

If milking is properly done, yields will be increased, time and labor will be saved, less infection or mastitis will be found, cleaner milk will be produced, and more profit will result.

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REVIEW

1 What parts of the animal are included in the mammary system?

2 How is the udder made up? How is it supported by the body?

3 What function has the blood in the production of milk?

4 Where is milk secreted? When is it secreted? How does internal udder pressure affect milk secretion?

5 What is proliferation? How is it observed in the cow?

6 How is milk secretion controlled?

7 Which hormone is known as the "let down" hormone? Under what conditions is it secreted?

8 What management factors are important in a good milking program?

9 Why is it important to milk quickly?

10 Name the main systems for machine milking

11 What is a pipeline milker installation?

21

Factors Affecting the Quantity and Composition of Milk

The yields of milk of an individual cow fluctuate from milking to milking, from day to day, and differ in any year from the yields of preceding or subsequent years. Changes in the percentage butterfat content (test) and also in the amounts of other components of the milk frequently occur. In many instances the cause and frequency of these changes is not understood and leads to disputes between buyer and seller. Some of the factors which are responsible for variations in milk yield and composition are discussed briefly in this chapter. A further discussion of several of the topics treated below is given in Chapters 5, 12, and 20.

Breed. Among the principal dairy cattle breeds, the large breeds such as the Holstein and Brown Swiss produce greater quantities of milk than do the small breeds such as the Jersey and Guernsey. On the other hand, Jersey and Guernsey cows produce milk having higher percentages of fat and other solids than do cows of the larger breeds. The volume and test of milk are just as truly breed characteristics as are coat color and shape of head.

Inheritance. The principal dairy cattle breeds have been developed through hundreds of years of careful breeding and selection for cattle capable of producing high milk yields. On the other hand, the beef cattle and dual-purpose breeds have been developed with different objectives and do not have the inherited capacity for high milk yields which typify high-grade and purebred animals of the dairy breeds.

The cows within any one dairy breed differ widely among themselves in their productive capacity because of differences in their inherited characteristics. Some animals have inherited a strong stimulus to produce milk while others possess this stimulus in lesser degree. (See Chapters 5 and 6.)

Growth, or size. Rapid and sustained growth resulting in large size at maturity is advantageous to the individual from the stand-

point of capacity for milk production As a rule, large cows produce more milk than do small cows of the same breed The same relation does not exist between different sizes of cows within a breed with respect to test of milk

Age at first calving. As a rule, cows calving for the first time at 30 to 36 months of age produce more milk during their first lactation than do cows which have their initial lactation at a relatively young age such as 20 to 24 months The greater size and advanced development of the older animal, although advantageous for the first lactation, may not bring about a greater lifetime yield[1] Income is delayed when the first calving is unduly postponed

Age at beginning of lactation The milk yield of a cow normally increases until maturity of the individual is reached (at the age of 5 to 6 years) and remains about stationary or increases slightly for 2 or 3 years For most dairy-cattle breeds, maximum yields are obtained at about 7 years of age After 8 to 10 years of age, yields decline slowly The test of the milk changes but little with age, except that after 10 years of age, it declines slightly The test of a cow's milk during her first lactation period is a good index to the test during the remainder of her lifetime

Single or multiple births Giving birth to twins or triplets is more of a drain on a cow's vitality than is the birth of a single calf Hence, the milk yield for the lactation which begins with a multiple birth may be less than in cases where there is but a single birth

Health and vigor Strong, vigorous, healthy cows produce more milk than do cows which lack vigor and are suffering from some ailment Mastitis, a disease frequently encountered in dairy herds, is likely to reduce milk yields greatly The disease also is responsible in many cases for blind quarters, that is, the drying up of one or more quarters of the udder When one or more quarters of an udder cease to function the remaining normal quarters may compensate somewhat for this loss but the total production of the cow is markedly reduced because of the udder defect

Length of lactation The number of days during which a cow produces milk greatly affects total yield Calving intervals 12 months in length, that is, the production of a calf once a year, are advantageous from the standpoints of (1) large total lifetime yield of milk, (2) enabling the farm operator to take advantage of favor-

[1] Chapman A B and Dickerson G E The Relation of Age at First Calving to Butterfat Production in the First Five Lactations Amer Soc Ann Prod, Proc 29 52–55

able seasonal market prices for feed and milk, and (3) facilitating the farm work program, such as planting, care, and harvesting of crops.

Season of calving. Cows calving in late fall or during the winter months usually produce higher annual yields of milk and butterfat than do cows calving in late spring or summer. The appetites of cows are generally best during cool weather. The stimulus of spring pastures helps to maintain milk yields of cows calving in late fall and early winter at a high level, whereas in the case of cows calving in summer or early fall this aid comes too late in the lactation period

Hot weather depresses the appetite presumably because cows have difficulty in giving off the surplus heat from their bodies. Conditions of high relative humidity make matters worse. During such periods, cows may eat much less than usual and milk yields may fall rapidly. Because of the unfavorable effect of hot weather on milk yields and also the need for labor for the care of crops during the growing season, many dairy farmers find it advantageous to have cows calve in fall and early winter.

With the advance of hot weather the test of milk usually declines, but when cool weather sets in, the test rises. The extent of this change is usually small for cows that calve in the fall or winter but may be large for spring-freshening cows, especially when weather conditions differ greatly from normal.

Occasionally, the test of milk falls drastically shortly after cows are turned to pasture in the spring. The remedy for this situation is to supply ample amounts of supplementary feed in the form of grain mixture or hay or both of these feeds.

Stage of lactation. The daily milk yield of high-producing cows which are given proper care tends to increase gradually until it reaches its maximum height 3 to 6 weeks after calving. From that point, the daily yield gradually declines, as shown in Table 21.1. The figures in the table indicate that about *one-eighth of the year's* yield is obtained during the first month after calving while during the tenth month (the last month of production in the case of cows calving at 12-month intervals) only 6 per cent of the annual yield is produced. The decline during the last 4 months is more rapid than during the early part of the lactation

The test of the milk follows a trend opposite to that of the milk volume. In the case of well-fed cows, the test usually declines for a few weeks while the milk yield is increasing and then remains fairly

Table 21 1 Proportion of Yearly Production Expected in Any Month *

Month from Calving	Proportion of Yield: Single Month %	Proportion of Yield: Total to Date %	Total Production to Date: Low Level †: Milk, lb	Low Level †: Fat, lb	Medium Level †: Milk, lb	Medium Level †: Fat, lb	High Level †: Milk, lb	High Level †: Fat, lb
1	13	13	830	32	1 150	45	1 490	58
2	13	25	1 640	64	2 310	00	2 980	116
3	12	38	2 440	95	3 410	133	4 390	171
4	12	50	3 180	124	3 440	173	5 700	222
5	10	60	3 850	150	5 380	210	6 930	270
6	10	70	4 460	174	6 260	244	8 060	314
7	9	79	5 025	196	7 050	275	9 085	354
8	8	87	5 540	216	7 760	303	10 010	390
9	7	94	6 000	234	8 410	328	10 830	422
10	6	100	6 410	250	8 975	350	11 550	450

* For cows calving at 12 month intervals and milked twice daily for a period of 305 days

† Level of production in each case as shown for tenth month which is total yield for lactation or year

steady until 3 or 4 months before the cow goes dry During these last 3 or 4 months, however, the test rises gradually with a sharper rise shortly before the cow is dried off

Number of days calf is carried Beginning about the fifth month of gestation, hormones depress milk secretion, causing the milk yield to decline more rapidly during the latter part of the lactation than during the early part (see Table 21 1) Because of the marked effect of gestation on milk yield, the mating of cows which are under A R test is sometimes delayed in order to obtain the highest possible production within a 305 day or 365 day period (See Chapter 12)

Length of rest period Within reasonable limits, the longer the rest, or dry period, the larger is the milk yield during the succeeding lactation An adequate rest period permits a cow to restore mineral vitamin, and tissue reserves which may have become depleted as a result of heavy production Under good conditions, rest periods of 6 to 8 weeks are usually ample A rest period of 60 days is commonly allowed if cows calve at 12-month intervals

Milking factors The skill with which the milking operation is carried out and the conditions surrounding the cow at the milking hour have been the subject of much research Some of the matters which deserve careful attention are discussed briefly in the following sections

Hormones The development of the mammary gland and some of the most important factors governing milk secretion are controlled by hormones The role of hormones in these processes and ways in

which man can take advantage of their effects in enhancing yields of milk are explained in Chapter 20

Number of daily milkings Experiments have demonstrated that increasing the number of milkings per day in high-yielding cows (1) increases the daily yield of the cow and (2) tends to make the cow more persistent in later lactations High-producing cows, especially those with small udders, yield up to 20 per cent more milk when milked 3 or 4 times daily than when milked only twice a day In cases of high-producing cows with highly congested udders, especially during the period immediately following calving, frequent milking is necessary in order to relieve the pressure in the udder and thus prevent injury to it There is but little gain in yield through frequent milking of low-producing cows

The number of times daily that cows should be milked is best determined for the individual cow In some herds a practice is followed of milking the highest producing cows 3 times daily for the first 60 to 90 days of their lactation period and then only 2 times daily In deciding upon the practice to be followed, consideration must be given to the question, "Does the extra milk obtained from 3X milking as compared with 2X pay for the extra labor and feed?"

Rapidity and completeness of milking Numerous experiments within recent years have shown that rapid and thorough milking is effective in maintaining milk yields at higher levels than when the milking process is unduly prolonged or done in a haphazard manner Rapid milking is conducive to a good hormonal response, as explained in Chapter 20, and also aids in the thoroughness with which the milking is done When considerable amounts of milk are left in the udder at milking time, the cow tends to secrete less In fact, this is the procedure commonly followed in drying off cows

Punctuality Milking at regular hours helps to prevent fluctuations in yields and test Studies of individual herds showed that milking cows exactly at the same hours each day aided materially in keeping yields and test constant, whereas varying the interval between milkings from one half to 1 hour caused changes in the test of as much as 0 5 to 1 0, and in some cases even more than this Moderate changes in the milking hour, however, did not greatly change the total daily yield of milk and butterfat (Compare Chapter 20)

Management Quietness kindness, gentle handling, and regular care are factors in management which influence milk yields Excitement caused by rough handling being chased by dogs, or fighting of the animals, is likely to reduce yields Excessive exercise caused

by traveling long distances to and from pasture may materially reduce yields Ample amounts of fresh water and shade on hot days are desirable (See Chapter 11)

Feed The amount and character of the ration are among the most important factors influencing milk yield and composition

Heavy feeding Liberal feeding of a well-balanced ration is necessary for the securing of high milk yields, as pointed out in Chapters 8 and 9 Feeding more than the needed amount does not increase the yield beyond the capacity of the cow to produce but such a procedure may influence the test of the milk for a time Liberal feeding prior to calving to the extent that the cow becomes fat usually induces a somewhat higher than usual milk yield and a considerably higher than normal test for a short period at the beginning of the lactation As a rule a highly fitted cow loses weight rapidly following calving and the test returns to normal within a few weeks

Underfeeding Extreme underfeeding for an extended period is likely to be disastrous in its effect on yield and test Under such conditions cows lose weight and both yield and test of milk fall With prolonged underfeeding, which sometimes occurs when pastures are dried up, both fat and other solids decline below normal in amount The use of suitable supplements of grain mixture or hay, or both, aids in preventing these abnormal effects on yield and composition and in correcting them once they have occurred

Composition of feed The dairy cow possesses the ability to keep the percentage of fat and other solids of her milk nearly constant in spite of wide variations in the kind, amount, and composition of the feed she consumes Some minor changes in these components are brought about, however, when feeds of certain kinds and qualities are eaten Important changes may occur in the flavor and vitamin content because of feed influences

The *flavor* of the milk may be objectionable when such feeds as cabbage, rape, and turnips are fed, or when cows at pasture eat strongly flavored weeds such as ragweed, wild onions, and dandelions In some cases silage feeding or the use of early spring pasture may cause flavors which are disliked by some people

The *vitamin content* of milk is subject to wide changes depending upon the vitamin content of the ration Fresh green pasture grass, green hay and green silage supply large amounts of carotene and when these feeds are freely consumed, the milk contains a relatively high content of vitamin A a colorless compound and carotene a yellow pigment The presence of carotene is indicated by a yellow

color After feeding cows for an extended period on feeds low in carotene content, the milk and butterfat become nearly colorless

The vitamin D content of milk is fairly good when cows have access to summer sunshine or are given sun-cured feeds, such as field-cured hay The content of this vitamin in winter milk is usually lower than that of milk produced in summer Because cow's milk does not normally supply all of the vitamin D needed by infants and young children, a vitamin D concentrate may be added to milk used for bottling

The vitamin E, or tocopherol, content of milk is strongly influenced by the amounts of this vitamin in the feed On the other hand, the ascorbic acid and vitamin B contents of milk are affected but little by the character of the ration

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REVIEW

1 Explain the relation if any between breed inheritance growth or size and the quantity and composition of the milk produced by cows

2 What is the relation of age (*a*) at first calving and (*b*) at the beginning of lactation to milk yields and test?

3 Discuss the effect of (*a*) single and multiple births and (*b*) health and vigor to milk yields

4 What is the best season for cows to freshen? Explain in detail the reasons for this

5 Explain the relation of stage of lactation to daily milk yield and state the effects of (a) number of days calf is carried and (b) length of rest period on yield

6 Discuss fully the effects of (a) hormones (b) number of daily milkings, (c) rapidity and completeness of milking (d) punctuality and (e) other management factors on milk yield

7 Give a detailed explanation of the effects of (a) heavy feeding (b) underfeeding and (c) composition of feed on the yield test and vitamin content of milk

22

Protecting the Quality of Milk; Merchandising Dairy Products from the Farm

When milk leaves the udder of a healthy cow, in the process of milking, it is of high quality and potentially an excellent food. What happens to it from that point until it reaches the consumer can be harmful or helpful. Its quality subsequent to this point cannot be greatly improved by good sanitary practices but its excellence can be preserved by them. Poor care and unsanitary practices in handling can ruin an initially excellent product.

In the handling of milk before processing and, in fact, during processing itself, the processor or manufacturer has on the whole done a better job than the farmer. Most of the contamination that gets into milk and the high bacterial counts that are frequently observed are largely the result of poor handling or management on the farm. It is therefore highly desirable for the milk producer to familiarize himself with the basically important items in producing and marketing a high-quality product.

Milk is easily contaminated. It is usually some form of microorganism that contaminates milk. These organisms as they are broadly referred to by microbiologists are (1) bacteria, (2) yeasts, (3) molds, (4) viruses, (5) bacteriophage. All are similar in growth habits and all require food for growth and development. Bacteria, yeasts, and molds require plenty of moisture for their growth and rapid multiplication. Bacteria generally grow best under what might be termed their optimum temperature. For different microorganisms the temperature may vary from almost as low as freezing to quite high temperatures, as high in some cases as 150–160° F.

Milk, especially when kept at room temperatures, provides an excellent food for microorganisms. Being in liquid form it supplies plenty of moisture for bacteria, and having been designed by nature to nourish the non-precocious young of mammals it also provides all of the nutrients needed in readily available form and in adequate

amounts Since microorganisms thrive so well in milk it is the primary responsibility of the dairyman to keep them out of milk

Microorganisms produce changes in milk In general such changes are chemical in character Certain bacteria change the physical properties of milk Examples of physical change are curdling, due to very high acidity, and ropy milk, caused by capsule-producing bacteria

Certain microorganisms endanger the health of consumers Most of the bacteria that get into milk are not harmful to the persons who consume it A certain group known as pathogenic organisms are, however, extremely harmful and endanger health It was to protect consumers from these disease producing organisms that pasteurization was made compulsory in most of the more important markets For a definition of pasteurization refer to the footnote, Chapter 1, page 4 Examples of harmful bacteria that are the causative agents of disease and have been found in milk are (1) typhoid fever (*Eberthella typhosa*), (2) undulant fever (*Brucella abortus*, *B suis*, and *B melitensis*, the last organism producing the disease known as Malta fever), (3) septic sore throat (*Streptococcus pyogenes*), (4) tuberculosis (*Mycobacterium tuberculosis*), (5) food poisoning due to the toxin production of *M aureus* There are other bacteria or viruses that might be similarly classified, such as those that produce diphtheria, scarlet fever, etc

It is logical for us to consider separately the major factors in producing high-quality, safe milk They are

1 Maintaining healthy herds and disease-free attendants

2 Using sanitary practices that keep dirt and bacterial contamination out of milk

3 Cooling milk immediately after milking and holding it at a low temperature until it is delivered to the processor

Maintain healthy herds and disease-free attendants It is very important that cows contributing to a milk supply be free of disease That is especially true of all diseases that can be communicated by animals or their products to human beings

Tuberculosis It has been demonstrated that bovine tuberculosis in humans has been contracted by drinking milk from infected cows This source of infection has decreased very markedly in the past 30 years, due to the gradual and now almost complete elimination of the disease in dairy cattle As a general practice humans should not consume raw milk It is always safer to pasteurize or even boil the

milk, especially from cows that have not been submitted to and passed tuberculin tests.

Brucellosis (abortion disease). Table 2.5, Chapter 2, page 19, shows that in 1952, 318,494 cattle in the United States reacted to the test for brucellosis. This represented 4 per cent of all of the cattle tested that year. Brucellosis in cattle can produce undulant fever in man. It has been estimated that from 3000 to 5000 cases of brucellosis in humans are officially reported to the Public Health Service each year.

It has been demonstrated that brucellosis in man is produced by three different types of brucella species. These are: (1) *Brucella abortus*, found in cattle, (2) *Brucella suis*, the cause of abortion in swine, (3) *Brucella mellitensis*, which is the type found io goats. Undulant fever can be contracted by contact with infected animals or by drinking raw milk. Pasteurization provides protection from the latter source of infection.

Mastitis. Any disease that invades the udder of a cow is referred to as mastitis. Many different organisms can produce mastitis in the cow. At least one of them, a hemolytic streptococcus, *S. pyogenes*, is responsible for septic sore throat in man. The septic sore throat organism is easily killed by pasteurization.

There are standard tests that can be used to detect the presence of each of these diseases in dairy cattle. The milk of animals that react to the test should be excluded from the milk supply.

Persons who work with cattle or handle milk should be free of disease. Attendants who handle milk or work with cows should be periodically checked by a competent physician to determine whether or not they are free of disease. It occasionally happens that an apparently normal person may harbor the germ of such diseases as tuberculosis, undulant fever, typhoid fever, septic sore throat, etc., and thereby endanger those who work with him or consume products he may have unwittingly contaminated. The consumer deserves protection. Producers and processors should work together to see that the consumer is not only protected but that he is advised and assured that such precautions have been taken to protect the safety of the milk which he consumes.

Precautionary measures to take in producing milk on the farm. Every producer of milk that is to be used for human food should feel a moral obligation to exercise care in the handling of his product and to keep it free of dirt and germs. He should milk only healthy cows

and they should be cared for by clean attendants who are known to be free of all trace of communicable diseases

CAREFULLY WASH ALL UTENSILS Wash utensils in clean warm water (120° F) to which has been added some good washing powder Usually one heaping teaspoonful of washing powder to each gallon of water used is adequate A brush with stiff bristles is superior to a cloth for this purpose Wash thoroughly until no trace of dirt remains in any of the creases or dents in the utensils Furthermore, be sure to wash all of the utensils that come in contact with the milk, including cans, pails, strainers dippers stirring rods, and sampling tubes Rinse thoroughly in clean hot (180° F to boiling) water

STERILIZE UTENSILS If utensils have been thoroughly washed, all of the visible dirt and 95 or more per cent of the bacteria will have been mechanically removed In order to destroy the remainder of the bacteria and prevent their multiplication in the can or pail, it is essential that such utensils also be given germicidal treatment Clean utensils are more easily treated than partially cleaned or soiled equipment It is seldom possible to kill all of the bacteria in utensils by any treatment that can be practically applied on the majority of dairy farms

Sterilization is usually accomplished in one of two ways (1) by heat treatment, (2) by chemical sterilizers Live steam is an excellent sterilizing agent Put all utensils that come in contact with milk into a sterilizer and introduce live steam under several pounds pressure In 10 to 15 minutes the utensils should be almost sterile Cans can be effectively treated by inverting them over a steam jet If a large volume of steam is introduced into the can for a period of 1 minute, effective germicidal treatment usually results Be sure to sterilize the lid of the can also After treatment invert the can on a rack and allow to dry before replacing the lid

Clean utensils that have been carefully treated with boiling water, if steam is not available, and then quickly and thoroughly dried have been successfully used in the production of high-quality milk

Electric sterilizers designed to provide both heat and a moist atmosphere have proven effective in treating utensils Such cabinets should maintain a temperature of 170° F for at least 15 minutes or a higher temperature for a shorter period All of the utensils used should be treated by this process

Chemical sterilizers of the chlorine group have been effectively used on dairy farms Such sterilizing agents should be used according to the directions of the manufacturer It should be emphasized

that every part of the utensil that comes in contact with milk should be thoroughly covered with the sterilizing solution. Drain the utensils that have been treated by such solutions, then thoroughly rinse with clear pure water, and allow them to dry.

BEFORE MILKING, CLEAN UDDER AND FLANKS OF COW. If the udder or flank of a cow has been soiled, remove all the loose material with

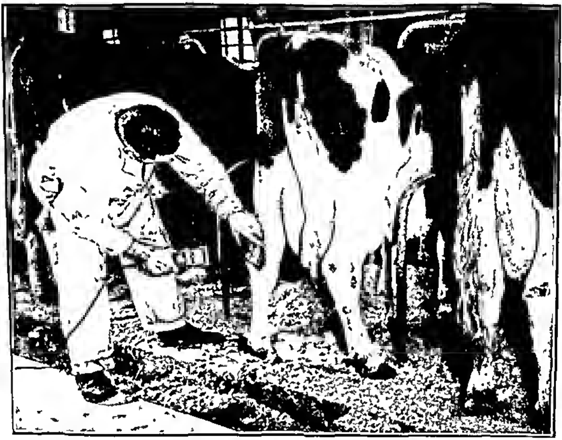

FIG 22 1 It is much easier to keep cows clean if their thighs, flanks, and udders have been closely clipped You will note that the operator has just finished clipping the cow directly in front of him, whereas the cow to his right has not yet been clipped. Observe the difference in their appearance.

a curry comb or brush and then wash the part with warm water and a cloth. This precaution will prevent dirt or other material from dropping into the pail during the milking process, or falling into the teat cups when milking machines are placed on the udder. Washing is facilitated if the flanks, thighs, and udder are kept closely clipped, as illustrated in Figure 22.1.

HAND-MILK WITH DRY HANDS IN PARTIALLY COVERED PAILS. In the larger herds milking is usually done by machines. But in smaller herds many cows are still milked by hand. Occasionally an individ-

ual forms a habit of moistening his hands before milking. Such a practice is decidedly unsanitary and should not be tolerated.

The value of a covered pail is inversely proportional to the cleanliness of the cow. The use of the covered pail is a safeguard and reduces the opportunity for dirt to enter the pail during milking. Figure 22.2 shows the reduction in bacteria due to the use of a partially covered pail.

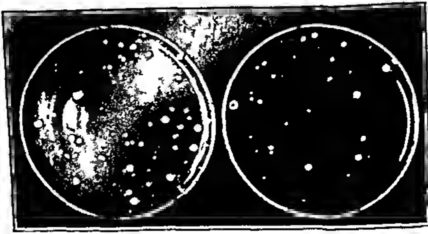

FIG. 22.2. A test of the value of the closed top pail for milking. This illustration shows colonies of bacteria grown from milk obtained from a fairly clean cow milked into a common open top pail (left) and into a pail with a partly closed top (right). The number of bacteria was reduced nearly three-fourths by the use of the partly closed pail. This demonstration was conducted at Purdue University.

CHECK FOREMILK FOR UDDER INFECTION (MASTITIS). Before the teat cups are placed in position for machine-milking or before hand-milking is begun it is well to milk out a few streams of milk from each quarter into a "strip cup." (Note Figure 22.3.) A strip cup is a cup like device fitted with a very fine wire gauze which acts as a strainer. Normal milk goes through this gauze readily but flakes of coagulated milk, indicating the presence of some invading organism, remain on the surface of the gauze and are easily observed. Milk containing coagulated particles or clumps should be excluded from the supply until the condition has cleared up and the udder is normal again.

STRAIN MILK THROUGH COTTON OR GAUZE. Great care should always be exercised to prevent the entrance of dirt into milk. If dirt does get into milk, and even with the most careful operator some sediment will find its way into milk, it should be removed by straining imme-

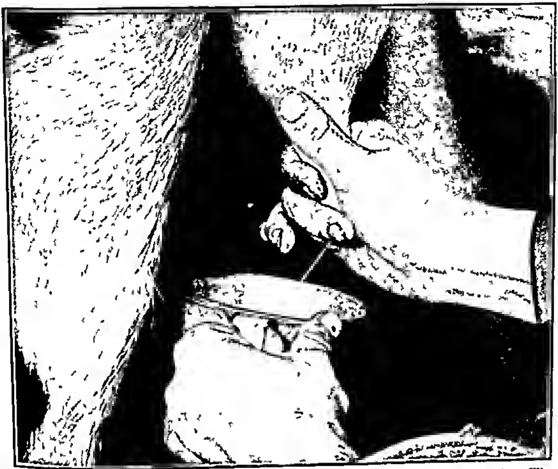

FIG. 22.3 The strip cup is an essential in producing clean, safe milk. The operator in this case is milking a small amount from each teat before he begins the regular milking. If he finds any coagulated milk on the wire gauze of the strip cup, he will withhold the milk of that cow from the market supply.

diately. Always strain the milk through a cotton pad or pad of several thicknesses of gauze. Do not permit milk to be poured directly on a cotton strainer pad or the cotton may be torn and the sediment released into the milk. Either cover the strainer between the times it is used while milking or have a fan blowing directly upon it. The blast of air from the fan will keep the flies away from the milk that is being strained.

GIVE MILKING MACHINES SPECIAL ATTENTION. In general, milking machines tend to keep visible dirt out of milk. Unless they are cleaned and sterilized properly, however, including the rubber parts, they may provide an excellent source of bacterial contamination. This source of contamination can be held to the minimum if the following procedures are rigidly observed:

1. The milking machine pail and other metal parts may be cleaned by the same procedures that are used for other dairy utensils.

2 After milking the last cow, immediately draw from 1 to 3 gallons of lukewarm water through each unit This is best accomplished by alternately submerging and withdrawing the teat cups from the pail containing the water This procedure tends to create a scrubbing effect Also rinse the milker pail thoroughly by this procedure

3 Dismantle the machine at least once each day (usually after the morning milking), and thoroughly wash all parts that come into contact with the milk in hot water (130° F) containing a properly balanced washing compound Use a brush to remove all foreign material Thoroughly rinse the parts and reassemble the machine

4 If the machine is not dismantled after a milking, rinse the machine as recommended in item 2 above and then in the same manner draw one or more gallons of hot water (180° F), to which has been added a good washing powder (2 tablespoonfuls per gallon of water), through the machine Rinse thoroughly and prepare for storage

5 Place the teat cups and rubber inflations upon a sterilizing rack This device is made so that the upper end of the milk hose and teat cups are at the same level The sterilizing fluid (0 4 to 0 5 per cent lye solution) is then introduced into the milk hose until the entire system is filled The fluid remains in the system until the next milking Drain out this fluid before reassembling the milker After assembling the machine, thoroughly rinse, as suggested in item 2 above, before placing the teat cups on the first cow for milking The machine pail should be sterilized along with the other dairy utensils

THE DETERGENT-SANITIZER METHOD This method employs a non-ionic wetting agent, polyphosphate, quaternary ammonium compound The procedures recommended are

1 After milking rinse the system thoroughly with water

2 Clean milk tube, teat cup inflations, milker pail, and head with detergent-sanitizer solution

3 Hang teat cup assembly and milker pail assembly on rack to dry without rinsing

4 Before milking rinse each unit in clear water or germicide solution

5 At least once each week disassemble machine and scrub all parts thoroughly with an organic acid detergent Permit rubber parts to soak in this solution between milkings

No matter what method of cleaning is used be sure that the rubber parts of a milking machine are free of cracks Replace all worn rubber parts as soon as the first hair cracks appear

Cool milk quickly and hold at a low temperature. It is very important that milk be cooled as quickly as possible after milking. Normal milk has a natural resistance to the growth of bacteria for several hours after it is drawn from the cow. The period of the duration of this resistance is greatly lengthened if milk is cooled to 36–40° F. soon after milking. Table 22 1 illustrates the rate of growth of bacteria in milk at various temperatures

Table 22 1. *Growth of Bacteria in Milk at Various Temperatures*

Hours Stored	Bacterial Count per Ml of Milk				
	Refrigerated Water, 38–40° F	Flowing Water, 51–52° F	Air of Room, 52–67° F	Air of Room, 72° F.	Air of Room, 72–82° F.
24	8,200	10,300	39,000	10 000,000	48,000,000
48	7,600	14,800	7,700,000	990,000,000	1,470,000,000

MECHANICAL COOLING. The National Rural Electrification Program has made it possible for the average dairy farmer to enjoy the advantages of electrical power. If a farmer can use motor-driven equipment, then mechanical cooling is the most effective answer to his milk-cooling problems

Mechanical coolers differ in design and operate on several separate and somewhat different cooling principles. In general cold water is used as the cooling medium, and (1) cans of milk are immersed in and remain in this cold water; or (2) cold water is sprayed over the cans to cool the contents, and the cans and contents are stored without immersing them in water; or (3) the cold-wall tank principle is employed, in which the milk is dumped or poured into the tank, is cooled, and remains there in bulk form until drawn off; or (4) surface cooling is used, in which milk is allowed to flow in a thin film over a corrugated cooler, thus reducing its temperature quickly to 35–38° F., and is then put in cans and stored in a dry box type of cooler.

All of these methods provide adequate cooling if operated according to the recommendations of the manufacturer They differ somewhat in cost and convenience of operation With the advent of refrigerated tank trucks and bulk pickup at the farm, the cold-wall tank is gaining in favor.

COOL WITH FLOWING SPRING OR WELL WATER If fresh milk can be cooled to 60° F. and held at that temperature until delivered, an acceptable quality of product can be produced. Table 22 1 indicates that when milk was held from 52–67° for 24 hours it contained

39,000 bacteria This would be considered acceptable milk on most markets Some springs and wells produce water that, throughout the year, seldom has a temperature above 55–57° F If water at or near this temperature flows through a relatively small tank containing cans filled with milk, the temperature of the milk in the can may be held at approximately 65° F except during the hottest period of the summer Figure 22 4 illustrates a tank of this type

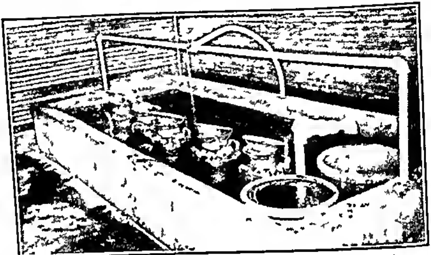

Fig 22 4 A cooling tank for milk The water reaches nearly to the neck of the cans Partly filled cans may be fastened to the horizontal rail above to keep them from tipping Cooling tanks are also used in winter to keep milk from freezing Note at the end of the tank the earthenware jars holding disinfectant solution in which milking machine tubes and teat cups are kept between milkings This tank could be improved by insulation and the addition of a cover

Small herds not conducive to quality milk production In areas where the majority of the herds are small (less than 10 cows) the quality of the milk delivered to market is usually below that sold by communities in which the herds are large (20 or more cows) The reason for this difference in quality can usually be traced to the better equipment and more sanitary practices on the larger farms Milk quality is important, and dairymen should observe the precautions necessary to produce and market a good product

Marketing milk from the farm. An important item in the success of a dairy farm is its program for effectively marketing milk or cream Most of the milk sold from the farm is disposed of to some processor who either retails it in fluid form or manufactures it into

cheese, condensed or evaporated milk, or some other consumable product From the producers' viewpoint a fluid milk market is on the whole the most satisfying The farm price per hundredweight of milk is usually somewhat higher than is the price paid for milk that is earmarked for manufacturing purposes Milk is usually paid for on the market according to grade and use

Milk grades The most generally accepted standard for determining milk grades is the U S Public Health Milk Ordinance and Code [1] This milk code specifies in detail the requirements for farm production and milk plant operation It also provides a basis for the legal interpretation of the milk ordinance There is occasionally some deviation from the U S Public Health standards by certain states and from city to city It is therefore important for a dairyman who is preparing to produce milk for a certain market to know the specific requirements of that market In general the grades of milk sold are

Grade A raw milk	Grade A pasteurized milk
Grade B raw milk	Grade B pasteurized milk
Grade C raw milk	Grade C pasteurized milk

The production requirements for raw milk are on the whole more stringent than for pasteurized milk of the same grade The B grade has somewhat less severe requirements than Grade A milk and Grade C milk will not qualify for either the Grade A or Grade B markets

There is a growing tendency for the quality of milk to be evaluated according to a single standard This concept is based upon the assumption that milk is either fit for human consumption or it should be rejected for that purpose A few markets are now beginning to operate on the single standard basis The idea has merit and more markets will probably accept the single standard for milk quality basis

Special milk markets During the past 20 years considerable progress has been made in developing special markets This is especially true of the products of certain breeds Perhaps the best known and most highly advertised of these special milk products is 'Golden Guernsey Milk" This product is produced and marketed under the auspices of a special organization, 'Golden Guernsey, Inc" It appeals to a special select trade and sells for a somewhat higher price

[1] Public health bulletins are issued from time to time stating the current regulations They may be obtained by writing the U S Department of Agriculture Washington D C

than regular milk Other dairy cattle breed associations sponsor special breed milk marketing programs of their own

CERTIFIED MILK Certified milk first came onto the market in 1893 It was not until 1907, however, that the American Association of Medical Milk Commissions was formed This organization then formulated regulations and standards regarding the production and sale of certified milk Certified milk represents the highest quality of milk produced, and it sells at the highest price paid for milk by the consumer Certified milk is produced under the direct supervision of the American Association of Medical Milk Commissions, Inc, or some agency approved by them Only especially equipped dairies are qualified to produce certified milk Certified milk is generally sold as raw milk and is used largely for infant feeding and in special milk diets for invalids The demand is limited and the quantity produced is highly sensitive to the demand

Marketing creom from the form Most of the cream produced on our farms ultimately finds its way to the creamery or centralizer and is there made into butter The greater part of such cream is sold as sour cream, though an increasingly larger percentage is being sold as sweet cream[1] at a slightly higher price A relatively small percentage is marketed as sweet cream for special purposes

SOUR CREAM Cream sours as a result of the multiplication and activity of the lactic acid bacteria (generally *Bacterium lactis acidi*) When the culture of such bacteria is pure the cream has a desirable flavor and produces a high quality of butter There are other organisms, however, which are often found in cream and which injure the quality Sour cream is marketed in all conditions and stages Because of this fact, some creamery operators have attempted to grade cream and pay a higher price for the better grades In fairness to both the farmer and the creamery operator, this should be done If it were the common practice, dairymen generally would pay more attention to the quality of their product with the result that they would receive a better price and the quality of cream and butter in general would be greatly improved

It was pointed out in an earlier chapter that the production of sour cream for butter manufacture has decreased to approximately half the volume marketed 10 years ago Competitive products, oleomargarine in particular, have absorbed much of this difference

[1] Sweet cream is either sweet or low in acidity It is possible to make a very high scoring and excellent quality butter from this product

The future of the sour cream market depends to considerable degree upon the quality of cream marketed and the kind of butter that will be produced Good butter will continue to be in demand

SWEET CREAM Cream that is marketed sweet for buttermaking is used for making of a special grade of butter and returns a somewhat higher price than sour cream Much of the sweet cream sold is used in the making of ice cream, in restaurants, hotels, etc In such cases, also, the cream brings a higher price than if marketed sour Such a special market, if it exists throughout the year, is satisfactory to the dairyman and leaves him his skim milk on the farm for livestock feeding

Marketing dairy products cooperatively. In this country, as in almost every other country, there is a growing interest in the cooperative marketing of dairy products Such a system of marketing can be made extremely useful if based upon the proper principles It is a fundamental principle that the agency which can render a given service in the most satisfactory manner and at the lowest cost will be the one selected, in the long run, to render that service Cooperative marketing, as well as every other system of marketing, is subject to this general law, and for this reason those who desire to substitute a cooperative system for the one now in vogue should strive to improve the methods of marketing, establish definite grades and standards for products, increase the efficiency of transportation and distribution—in short, perform the marketing service better than it is now performed, or can be performed, by private agencies When a system of cooperative marketing of dairy products is established in accordance with such standards it is likely that marketing in this way will become a more common practice

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REVIEW

1 Why is milk easily contaminated with bacteria?

2 What milk borne microorganisms endanger the health of people?

3 What is brucellosis in cattle? How is the disease recognized in people and what is it called?

4 What is mastitis? How is it caused?
5 Give the essential steps in producing good-quality milk on the farm
6 How may utensils be sterilized?
7 Explain how you would clean and sanitize a milking machine
8 Why is it important to cool milk?
9 What are milk grades?
10 What is certified milk? How is its production supervised?
11 How is sour cream used?
12 How does temperature affect the growth of bacteria in milk?

23

Grassland Farming on Dairy Farms

The need for soil conservation has been so widely emphasized in recent years that farmers have become well aware of its necessity. Our soils must be conserved if the United States is to maintain its high position among the nations of the world. Food requirements will increase and the increase can only be met by keeping all of our tillable land in a highly productive condition.

In conserving the soil the dairy farmer has two definite advantages over the grain farmer. The forage crops needed for feed on the dairy farm do a double duty. They not only supply feed but conserve the soil by controlling erosion and maintaining good soil tilth. For the grain farmer, the forage crops serve for soil conservation only. Further, the dairy farmer, by caring for and utilizing the manure produced, can return to the soil a large percentage of the plant nutrients in the crops he grows for feed. The grain farmer must purchase large quantities of commercial fertilizers to replace the nutrients removed in the grain he sells. The dairy farmer has a much lower fertilizer bill.

What is grassland farming? The term grassland farming is generally used in a broad sense. It includes areas kept in sod crops (clovers and grasses) all of the time as well as land on which sod crops occupy a frequently recurring place in a regular crop rotation. Grassland farming is a type of farming which makes use of the characteristics of forage crops to maintain or increase soil productivity by controlling erosion and by maintaining or improving soil tilth. It is desirable to keep as high a proportion of the farm in pasture and meadow crops as is consistent with the need for soil maintenance and adequate financial returns. The objective is to keep the soil in a high state of productivity. In a few instances of grassland farming, such as growing alfalfa or other hay for market, the farm income may be derived solely from the sale of crops produced, but in most cases where this type of farming is carried on, livestock is kept to consume all or a large portion of the pasture and

meadow crops grown. Because of soil and climatic conditions, grass is the only or chief livestock feed which can be produced on much of the western range land. Here grassland farming may be said to be followed to a maximum degree but the term usually applied is ranching rather than farming.

Learning advantages of grassland system. The subject of grassland farming covers so wide a field and is of such great importance

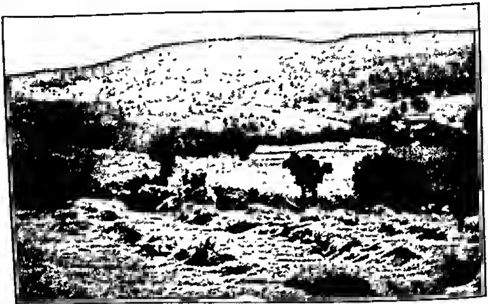

Fig. 23 1. Keeping hilly land in meadow and pasture crops and the steepest land in tree crops is necessary in some regions. Many dairy farms are located in areas such as this.

that a large number of articles and books have been written concerning it. Space limitations here permit only a brief summary of some of the most outstanding advantages of this system.

Food production from untillable land. It has been estimated that 779,000,000 acres of land in the United States would produce little if any human food were it not for the grazing of this area by livestock. Most of the large areas of untillable land are located in the western states, but in other sections of the country there are thousands of farms which have some unplowable land. The meat and milk produced by livestock from the forage grown on untilled areas contributes greatly to the nation's food supply. Were meat and milk produced only from crops grown on tillable land, the national diet would contain only small amounts of these foods. As the number of people living from the products of a given land area continues to in-

crease, there is a tendency toward the production of those crops and foods which will give the largest amounts of food energy and food protein per acre An acre of such crops as potatoes wheat, corn, and rice provides several times as much food energy and protein as does the meat or milk produced from the crops produced on that same acre In livestock production, a considerable portion of the crop is used for the maintenance of the animals and is not available as human food The highly desirable nutritive qualities of animal products in the diet, however, and the benefits gained from livestock farming in the maintenance of soil productivity justify the use of animal products in the diet so long as the total quantity of food produced by a combination of livestock farming and food crop production provides sufficient food for the nation

Livestock production possible on tillable land The profitable keeping of livestock is not confined to non-tillable areas The inclusion of pastures and meadows in crop rotations makes possible good returns from livestock on the most productive soils, and at the same time aids in maintaining soil productivity In most cases, the economical use of grassland on highly productive soils requires the keeping of those species and classes of livestock which can best utilize large amounts of forage Cattle and sheep are superior to other species of farm animals for this purpose, but even within these species there are wide differences in the amounts of forage consumed, depending upon the purposes for which the animals are being fed Under the usual conditions of feeding livestock in a grain-producing section of the Corn Belt, for every 40 acres of forage from pasture and meadow, feeder cattle are fed about 60 acres of grain crops, beef-breeding cows, on the other hand, utilize 79 acres of pasture and meadow crops for every 21 acres of grain Dairy cattle are similar to beef-breeding herds in their use of feed crops, using 78 acres of pasture and meadow crops for each 22 acres of grain Flocks of breeding sheep are highest in their utilization of roughage in proportion to grain, consuming only 8 acres of grain for every 92 acres of forage Hogs are lowest in consumption of roughage, requiring 90 acres of grain crops for each 10 acres of forage [1]

It can be seen from the above figures that dairy cattle rank high as consumers of roughage Under an intensive grassland farming program which includes the use of grass-legume silage for both winter

[1] Mosher M L The Amounts of Feed Used to Produce 100 Pounds of Liveweight of Animals or Its Equivalent of Milk on Farms of North Central Illinois Ill Farm Econ No 174–175

feeding and pasture supplementation, well-fertilized grass-legume pastures and fertilized legume or grass-legume meadows, the proportion of grain crops to pasture and meadow crops utilized by dairy cattle may be reduced below the amount given above

Low cost of production In most cases pastures and meadows need be reseeded at much less frequent intervals than other crops Further little labor is expended in maintaining grasslands once the

Table 23 1 *Cost of Producing Total Digestible Nutrients in Various Crops* *

Crop	TDN Yield per Acre, lb	Cost of Producing 100 Pounds TDN, dollars
Permanent pasture (5-year average)	2899	0 69
Rotation		
Corn silage (first year)	4270	1 22
Wheat and fall grazing (second year)	2188	1 83
Grazing (third year)	2761	0 64
Hay and grazing (fourth year)	3159	0 87
Hay and grazing (fifth year)	3130	0 76
Average (5 years)	3100	1 07

* Hodgson R E What to Expect from Pasture, Hay and Silage BDI-Inf 133 U S D A.

seedings have become established A considerable outlay of funds is usually needed for seed, fertilizer, power, and labor when establishing a new pasture or meadow, but the expense when prorated over a period of years is generally less than the cost of planting and cultivating annual crops

The greatest economy in the use of grassland crops is found in the harvesting costs The outlay for labor and power in the care of pastures is less than it is for the harvesting of small grain and tilled crops

The economy of pasture and hay as sources of feed nutrients is well illustrated in recent experiments conducted at Beltsville, Maryland (Table 23 1) The costs of producing nutrients in a 5-year crop rotation were much less during the years when only grazing, or grazing and hay, crops were grown than during the first and second years of the rotation when the crops were corn for silage and wheat followed by fall grazing The costs of nutrients in the combined hay and grazing crops were a little higher than the nutrient cost in continuous pasture The yield of nutrients in the so called "permanent"

pasture was good for this type of pasture, thus making the cost of nutrients low. Often land kept continuously in unimproved pasture yields only 1000 to 2000 pounds of feed nutrients to the acre.

Weed control. The grazing of livestock is an effective aid in combatting the spread of some species of weeds which often cause damage in tilled crops. Many of the weeds of the grass type, such as crabgrass and several varieties of foxtail, are readily consumed and

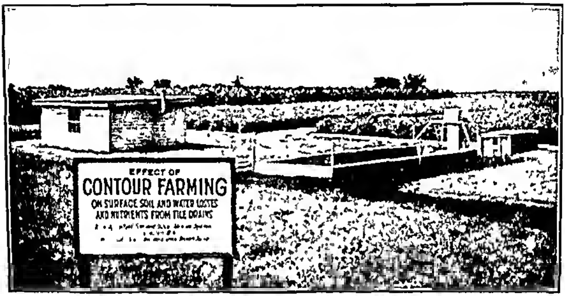

FIG 23 2 Careful measurements of run-off water and soil losses from sloping land have conclusively demonstrated the erosion-preventing properties of grasses.

seed production is thus prevented. Heavy fertilization stimulates the growth of useful forage species of grass and tends to crowd out weeds, such as broomsedge, which are low or lacking in forage value. Then, too, the introduction of improved, strong-growing species of pasture and meadow grasses and legumes may simply and effectively displace weeds. Poisonous species of weeds in range areas, however, usually require special methods of control.

Insect control. A rotation which includes pasture or meadow is an effective aid in the control of numerous insect pests and plant diseases. Examples of these are corn rootworm and leaf blight.

Soil conservation. The chief advantage of grassland farming is the vital part which it plays in the conservation of the soil. Grass forms an effective cover which aids in preventing or reducing to a low point erosion and losses of soil through heavy rains, floods, and strong winds. Without grass, sloping soils soon become gullied and may lose their usefulness for cropping purposes. Surface erosion

removes the best portion of the soil that is the part containing the organic matter and readily available plant nutrients

Soils which lack a vegetative cover are subject to leaching of the plant nutrients These nutrients slowly become soluble and available for the use of plants but when the soil is bare of crop, leaching of the nutrients takes place

FIG 23.3 A pasture research study at the University of the Witwatersrand in the Union of South Africa is an indication of the wide interest in grassland farming (Courtesy Doctor D Meredith)

With heavy or continuous cropping of intertilled or small grain crops the supply of organic matter in the soil becomes depleted Soils low in organic matter have poor tilth that is they are hard to work become cloddy if worked while wet hold little water drain poorly, and dry out quickly The lowering of the organic matter content through continuous cropping makes the soil dense and hard Grass crops help to distribute organic matter throughout the surface layer of the soil and deep rooted legumes carry organic matter much below the plow layer When use is made of good rotations which include grasses and deep rooted legumes for pasture or meadow, and crop residues animal manures and green manures are utilized to their full advantage the organic matter of depleted soils may be increased thereby improving the ease of working water holding capacity, drainage and crop productivity

Maintaining the nitrogen content of soils is simplified when legumes are grown Legumes may take as much as two thirds of their nitrogen from the air This nitrogen costs nothing and if

the legumes are plowed under, it is added to the soil. Grazing the crops is even more effective because the plant food is returned directly to the soil in a form which the sod crops can readily use for continued and increased growth. The value of the sod to succeeding row crops is improved through well-managed grazing.

An illustration of the soil building and soil maintenance ability of grass is found in the grassed division strips of the Jordan Fertility Experiments at the Pennsylvania Agricultural Experiment Station.

Table 23.2. *Relation of Cropping System to Soil Aggregates* *

Cropping System	Percentage of Effective Soil Aggregates
Bluegrass sod	79
Corn-oats-clover + MLP †	47
Corn-oats + MLP †	32
Continuous corn + MLP †	22

* Stauffer, R. S., et al. Organic Carbon, pH, and Aggregation of the Soil of the Morrow Plots as Affected by Type of Cropping and Manurial Addition. J. Amer. Soc. Agron., *32*:819–832, 1940.

† Manure, Lime, and Phosphorus.

After the investigation had been under way for 72 years, it was found that there had been a gradual building up of the nitrogen content of the soil in grassed but uncultivated strips and roadways.

Another illustration of the soil building and soil maintenance ability of grass is found in data from the Morrow Plots at the University of Illinois (Table 23.2). The sod border, which has been kept in bluegrass sod since 1904, contains a higher percentage of soil aggregates than the corn-oats-clover plot which has received fertilizer during the same period. The sod border has received no fertilizer. The table shows that the bluegrass sod, even though not fertilized, was an effective agent in soil building and soil maintenance. It contained a high percentage of soil aggregates, a condition which indicates good tilth, aeration, and moisture relations, such as drainage and water-holding capacity.

Protection of the soil from erosion during the autumn, winter, and early spring months is brought about to a greater degree by sod crops than by crop residues, such as grain stubble, corn stalks, and soybean straw, since the roots of the grasses and legumes grasp and hold the particles of soil. A good sod cushions the soil and protects it from the forming of ruts and small waterways after harvesting machines or livestock have passed over it.

Finally, grass and legume crops are the most effective and most satisfactory means now known for safeguarding for future generations the soil and the stores of plant food within the soil. A well-planned system of livestock farming in which suitable acreages of

Table 23.3 Average Annual Yields of Crops and 12-Year Yields of Grain and Total Digestible Nutrients from Unfertilized and Fertilized Plots *

Crop	Continuous Corn		Corn-Oats Rotation †		Corn-Oats-Clover Rotation	
	Unfertilized	Fertilized	Unfertilized	Fertilized	Unfertilized	Fertilized
Corn, bu	20.8	61.5	31.8	94.2	62.1	97.1
Oats, bu			34.3	67.6	48.9	64.9
Clover hay, tons					0.87	3.56
Total grain for 12-year period, lb	13,978	41,328	17,270	44,630	20,170	30,057
TDN in grain and hay for 12 years, lb						
Corn	10,763	31,823	8,227	24,371	10,711	16,749
Oats			4,873	9,605	4,632	6,147
Hay					3,480	14,240
Total	10,763	31,823	13,100	33,976	18,823	37,136

* Calculated from data published by F. C. Bauer and C. H. Farnham. The Morrow Plots. Ill. Agr. Exp. Sta. Mimeo.

† Sweet clover used as a catch crop in oats and plowed under for corn.

grasses and legumes are grown and manures are carefully conserved and returned makes possible the maintenance of soil organic matter and crop productivity even though a portion of the farm is devoted to the growing of grain crops. Some mineral fertilizers will be needed from time to time to restore the mineral elements removed from the farm in livestock, milk, crops sold, and leaching and erosion of soils. But the amounts of fertilizer needed are much smaller than when the farmer's income is derived from the selling of grain.

Without grass and legume crops, the maintenance of a high organic matter content, good tilth, water-holding capacity, and crop productivity would be well-nigh impossible, even though mineral fertilizers are applied and crop residues are returned. These facts are borne out by numerous long-term investigations, including those on the Morrow Plots (Table 23.3). Grassland farming points the way

to a long enduring and highly productive type of agriculture. A decreasing use of grasses and legumes in American farming is a direct and sure road to decreased food production, a lowered standard of living, and destruction of our most valuable natural resource, the soil.

FIG 234 Troublesome grain crop surpluses and government price supports might be prevented in part by greater use of grassland crops and livestock production

Considering the disadvantages of grassland farming. The advocates of intensive grassland farming often do not call attention to the disadvantages or possible causes of failure of such a system It is only fair that the limitations as well as the merits of a plan of action should be given careful consideration.

Lower production per cow. High production per cow is commonly obtained through the feeding of large quantities of grain and other concentrates in addition to roughage On farms where milk or cream is sold, the amounts fed for each 100 pounds of milk produced range from less than 20 pounds in some of the western states to more than 35 pounds in many of the south Atlantic and south central states.[1] On farms where milk is produced for home use only, the amount of concentrates fed is considerably less. For all farms where milk was produced, the amount of concentrates fed to milk cows in recent years has averaged nearly 1 pound for each 3 pounds of milk produced.[1]

From 1930 to 1935, the amount of grain and other concentrates fed to milk cows ranged from 900 to 1200 pounds per head, while during

[1] Rations Fed to Milk Cows Bur. Agr Econ, U.S.D.A.

he 1945 to 1950 period the quantities fed ro e as high as 2000 pounds per cow These figures are average values for the various geographical regions of the country The heavier rates of grain feeding which began about 1939 have undoubtedly been one of the most influential factors in causing the marked increase in the yields of milk per cow which have been noted during this period The heavier feeding of grain was found practicable because of a more favorable ratio between feed prices and milk prices

Were an all roughage system to be substituted abruptly for the present roughage and concentrate plan of feeding production per cow would undoubtedly be drastically reduced It is only when pastures and meadows have been so radically improved that they produce an abundance of high quality grass legume or all legume roughage that liberal yields of milk per cow can be obtained from all roughage feeding Even under the best systems of roughage feeding production per cow is usually considerably less than when both high quality roughage and concentrates are fed Experiments carried out by the Bureau of Dairy Industry of the U S Department of Agriculture show milk yields on roughage rations to have been two thirds to three fourths as large as when both roughage and grain were supplied (Table 23 4) It must be kept in mind, however,

Table 23 4 Production of Milk by Holstein Cows When Fed under Different Systems *

	Milk Yield lb	Relative Production %
Alfalfa hay corn silage pasture and grain (1 lb to each 4 3 lb of milk)	12,886	100
Alfalfa hay pasture and ground barley (1 lb to each 6 5 lb milk)	11 086	86
Alfalfa hay corn silage and pasture	9 481	74
Alfalfa hay and pasture	8 938	69

* Hodgson R E The Dairy Cow and Grassland Farming BDIM Inf 71 U.S D A

that all roughage systems of dairy farming may be profitable in some areas because of climatic factors soil conservation values economy of production of grass crops and lower cash operating costs

Fewer enterprises An all grass system of farming limits the number and kinds of livestock or crop enterprises in which a dairy farmer may engage Many dairy farmers who receive the largest portion of their income from the sale of milk or cream carry some

other livestock, such as swine, or produce some cash crop, such as potatoes, to give full employment to their labor force and to increase the cash returns from the farm. Such enterprises as these are seldom possible or practicable when most of the farm area is devoted to grasses and legumes.

Special adjustments needed. Only ruminants can utilize roughage as a considerable proportion of the ration. In regions in which dairy cattle require shelter in the winter (a condition found in most of the principal dairy regions of the United States), the adoption of an all-grass system of farming would probably require a larger number of cattle, more buildings to house the cattle, and more dairy equipment than is required when grain crops are grown on a part of the farm acreage. On the other hand, some of the buildings and equipment now used for crop production and the keeping of other livestock might not be used to advantage if most of the farm acreage were to be devoted to pastures and meadows.

Adopting a grassland program. In a grass-farming program where most of the income is derived from the dairy herd, all of the operations which contribute to the success of the enterprise must be efficiently carried out. A few of the more important of these operations are briefly discussed in the following sections.

Produce high-quality product. Since there is usually a wide difference in the market prices paid producers for dairy products of different grades, the grassland dairy farmer should seek the highest possible returns through the production of high-quality dairy products In a few instances, there is opportunity for the production and sale of specialized grades of milk, such as those bearing the names of the dairy cattle breeds or milk used for special processing purposes.

Select good roughage eaters. A feeding program which calls for the use of mostly or only roughage is not likely to be successful unless the cattle are capable of consuming large amounts of roughage The selection of such animals is not a matter of choosing one breed as being superior to another in this respect, and inheritance is not necessarily a determining factor. It has been definitely established, however, that large cows within a breed consume more and produce more than do small cows of the same breed. There are usually wide differences between the various members of the dairy herd with respect to their roughage-consuming habits and it is therefore desirable that these differences be determined by weighing the roughage consumed over certain periods or by careful observations. Cows which are exceptional as roughage eaters are found within each of the breeds.

Furthermore cows and heifers may be trained to increase their consumption of roughage through the offering of only the highest quality feeds through the use of well timed and executed feeding methods, and through the keeping of the mangers and feed bunks in the best sanitary condition

Produce high-yielding crops The income of the dairy farmer is derived from two sources, namely, the production of crops (whether they be grass crops or grain crops) and the production of milk and

FIG 23.5 High yielding grass crops and high yielding dairy cows make possible good farm incomes without the use of large amounts of farm grains

cattle Low yields in either of these phases of production mean a lower income than when high yields are obtained in both For the grassland farmer, this means that pastures and meadows must be made to produce the highest possible yields consistent with costs and that every effort be made to preserve the harvested forage in the best possible manner When legumes are extensively grown in pastures and meadows, when the excreta of the cattle is carefully conserved and returned to the fields and when attention is given to replenishing the mineral needs of the soil through the purchase of commercial fertilizers there will be little need for the purchase of protein supplements or nitrogen fertilizers In fact the grassland dairy farmer who makes full use of legumes and livestock is in a relatively secure position with respect to his needs for purchased supplies

Keep reserve feed supply Occasionally the yields of pastures are seriously reduced because of unusually low rainfall For full insurance against such a contingency, it is a good practice to provide

a large reserve supply of hay and silage which is regularly carried over the winter feeding period so that it can be drawn upon during the summer following the year in which is was produced.

Failing to make grass farming pay. Just as in other types of farming, there are conditions which lead to low income or to failure in the operation of a grass farming enterprise. Factors which contribute to such conditions are (1) failure to correct and replenish the mineral deficiencies of soils in order to make them capable of growing legumes, (2) the use of low-yielding or unadapted crops or varieties, and (3) too high a proportion of the farm in grass and legume crops.

Conserving manure. One of the valuable by-products of a grassland-livestock-farming system is manure. On dairy farms the availability of manure makes the job of conserving soils a comparatively simple one.

Amount of manure produced. An experiment with twelve Holstein cows at the New Jersey (Sussex) Research Farm showed a production of 21 tons of manure a year for a 1300-pound cow.[1] Of this, one-fourth was urine and three-fourths feces. Each ton of the mixed excreta contained 9 5 pounds of nitrogen, 3 pounds of phosphoric acid (P_2O_5), and 8 pounds of potash (K_2O). The analyses of the feeds and the excreta indicated that 70 per cent of the nitrogen of the feed, 63 per cent of the phosphoric acid, and 86 per cent of the potash were present in the manure. The difference between the amounts in feed and manure represented the amounts in the milk and animal growth, including the developing fetus, or calf.

Value of manure. The amounts of fertility elements excreted annually by a large dairy cow, using the above figures as a guide, are, therefore, equivalent to the amounts supplied by a ton of commercial 10–6–8 fertilizer. Unfortunately the value of urine as a fertilizer is generally given too little attention. In studies of milking cows fed various types of rations, it was found that the urine contained from 20 to 50 per cent of the nitrogen, from 50 to 90 per cent of the potassium, and only 1 to 3 per cent of the phosphorus of the feed consumed.[2] When cows' urine was used as a fertilizer for bluegrass

[1] Bear, F. E., and Bender, C B Manure and Grass Farming. Yearbook, U.S.D.A., pp 289–296, 1948

[2] Harshbarger, K. E., and Nevens, W. B The Distribution of Elements of Fertility between Feces and Urine in Dairy Cattle Proc. Amer. Soc. of Ann. Prod., 1938

pastures both the protein content and dry matter yield of the forage were increased as much as 50 per cent and in some cases 100 per cent[1] It is difficult to evaluate manure in terms of dollars Experiments have shown that the beneficial effects of a single manure application on crop land may continue over a period of years Not only are crop yields increased, but the plowing under of manure improves the tilth and the water-holding capacity of the soil

Losses in manure It is rarely possible to save all of the manure produced on a dairy farm Large losses of urine occur unless special methods and unusual care are taken to conserve it Fermentation proceeds rapidly in slightly moist manure, particularly in warm weather causing large losses of nitrogen in the form of gaseous ammonia given off into the air Other losses result from leaching of the fertility elements by rain water when manure is improperly stored in piles or when it is spread on bare sloping fields or on frozen ground Under good conditions of care three fourths of the manure may be usefully applied to crops, but under poor conditions three fourths may be lost

Saving manure The best way of saving the urine and applying it to the soil is to use large amounts of dry absorbent bedding Straw and corn stover are among the best materials for bedding for they not only absorb liquid manure readily but also contain in themselves large amounts of plant nutrients Absorption of liquid is more rapid and the manure is more easily spread when the bedding is chopped before use Shavings sawdust refuse hay, peanut hulls peat moss ground corncobs and sugarcane residues may also be used Bedding that is unusually dusty should not be used in barns where cows are milked A deep manure pack to which fresh bedding is added daily as is customary in pen (loose housing) barns is a distinct aid in the conservation of urine In some European countries urine is customarily collected in cisterns and spread on the land from tank wagons The custom is finding some use in this country and is deserving of far wider adoption

The loss of nitrogen from manure can be prevented in part by spreading superphosphate over the floor and gutter behind the cows About 1 pound per animal daily is recommended It may also be added to loads of manure before they are hauled to the field When a 20 per cent grade of superphosphate is added at the rate of 50

[1] Nevens W B Cows Urine as a Fertilizer for Bluegrass Pastures J Dairy Sci 24 761-9

pounds to the ton of manure, a 10-ton application of manure supplies approximately as much nitrogen, phosphoric acid, and potash as is contained in 1000 pounds of 10–15–10 fertilizer. Reinforcing manure with extra phosphorus is especially beneficial in a grass-legume program. On many soils which are low in phosphorus the application of ample amounts of phosphorus either in manure or commercial form is needed to obtain satisfactory growth of clover.

FIG 236 In the Southeast, Kudzu aids greatly in controlling erosion on steep slopes and in gullies and also serves as excellent legume pasture. (Courtesy, Soil Conservation Service, U.S.D.A.)

Manure is best stored in pits having water-tight floors and sidewalls. To avoid extensive losses, keep the manure thoroughly wet and well packed. A roof is not necessary. The loss of nitrogen from urine in storage tanks or cisterns can be practically eliminated by keeping a heavy coating of mineral oil, about one-fourth inch thick, on the surface of the liquid. Losses of manure can be kept at a minimum when conditions permit spreading on the fields daily as the manure is produced. Applications are best made on some growing crop, such as young pasture or meadow. When used on plow land, it is most effective when spread just prior to plowing it under.

Utilizing manure. In grassland farming, the use of manure produces fully as marked effects as in grain farming but the increases

in yields cannot be as readily measured. Both grasses and clovers quickly respond to manure applications, provided the lime and minor element requirements have been met

Pastures are greatly benefited by manure applied in early spring or in autumn before growth ceases When supplemental roughage is given during the pasture season, the feeding is best done on the pasture This procedure conserves both the liquid and solid manure excreted while the cows are feeding, together with bits of refuse feed, and also saves labor as compared with feeding in barn or dry lot and hauling the manure to the fields It is best to move the feed rack daily. A feed rack on wheels facilitates this operation Feeding in a fenced-off portion of the pasture, such as a 5-acre tract, is recommended when pasture forage is not grazed but is harvested daily and hauled to the cows. The area where the feeding is done may be a field which is rotated with other portions of the pasture at least once a year.

Applications of as much as 20 tons of manure to the acre may be made on grasslands with beneficial results provided the grasses and clovers are not smothered by chunks of manure or coarse bedding When the manure supply is limited, greater returns from it can be obtained by spreading more lightly than this rate, thus covering a larger area.

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REVIEW

1 What is meant by grassland farming?

2 List five advantages of the grassland farming plan and explain each advantage in detail

3 Name three disadvantages of grassland farming and explain each

4 What is the relation of grain feeding to yield of milk per cow? Can milk yields under a grassland farming system be satisfactory?

5 Explain each of the procedures which must be given special attention when a grassland farming system is adopted

6 Under what conditions may grassland farming fail to make adequate returns?

7 What quantities of (*a*) urine and (*b*) feces are produced annually by a dairy cow?

8 What are the chief plant-food nutrients found in the (*a*) urine, (*b*) feces, of a dairy cow? What is the dollar value of these components?

9 What is the extent of the losses which occur in manure and how can these losses be prevented?

10 Explain good procedures for saving and utilizing manure

24

Improving Dairy Cattle Pastures

Improving the pastures is one of the most profitable of all field operations on dairy farms where a pasture improvement program has not been carried on. Increases in milk yield per cow and in gross farm receipts often can be traced directly to improved pastures.

Studying the advantages of pasture. Among the many advantages of devoting a part of the farm acreage to the growing of pasture crops for dairy cattle, those listed below merit special consideration.

Pastures save labor. When the dairy herd is pasture fed, much less hand labor is needed for the care of the herd, including feeding, grooming, cleaning stables, hauling feed and bedding, and keeping the herd comfortable, than is the case during the barn feeding season. The reduced barn work program comes at a time of year when the labor is needed for the growing and harvesting of crops.

Pastures can be grown on non-tillable land. A large portion of the land on which dairy cattle graze is unsuited to the growing of tilled crops. Many of the dairy farms of the United States exist because dairy cattle can profitably use the pasture forage produced on non-tillable land. The yields of these pastures, however, are likely to be low unless careful attention is given them.

Pastures conserve the soil. Keeping land in pasture crops is one of the most effective procedures for keeping at a low level the leaching of plant nutrients and losses of the soil through erosion.

Pastures aid in soil improvement. Not only does the growing of grasses and legumes improve the physical properties of the soil, but also in the grazing of pastures much of the fertility of the forage is returned directly to the field.

Pastures benefit crops which follow. On tillable land, the use of pasture land in a crop rotation not only improves the yields of crops which follow, but also aids in weed control.

Pastures supply nutrients cheaply. As a rule, the cost of nutrients in pasture forage is less than that in rations composed of silage, hay, and grain or in freshly harvested green crops, or combinations of

these feeds (Table 23.1). The chief reasons for the economy of pastures are (1) the saving in labor, (2) the cost of establishing a pasture is spread over several years, thus making the yearly cost low, and (3) high-yielding pastures may furnish more nutrients to the acre than do grain crops.

Pastures benefit herd health. Fresh, green pasture forage is high in its content of vitamins, protein, and minerals. Exposure to sunlight (in moderation) and exercise (when not excessive) are also beneficial factors.

Considering the disadvantages of pasture. While there are numerous advantages in the use of pasture as a means of supplying roughage to dairy cattle, there are also a number of disadvantages associated with this plan of feeding.

Pasture yield is changeable. The yields of pasture change from week to week with advancing development of the grass or legume crop, weather conditions (rainfall and temperature), and intensity of grazing. Grass pastures may become dormant (make no growth) during midsummer. All of these conditions must be taken into consideration when planning rations for summer feeding of the dairy herd (Chapter 9).

Pasture composition and nutritive value vary. As the season advances, grasses pass through a complete cycle of development in which the protein and moisture content become lower, the crude fiber content higher, and the digestibility and nutritive value sharply decline. With cool weather and abundant rains in autumn, rapid growth may be resumed. Most legume crops used as pasture undergo less marked changes than do the grasses.

Pastures change in palatability. Pasture forage changes quickly in its appetizing qualities as the moisture content changes. Cattle eat succulent green forage greedily but may consume only small amounts of ripe, dried-up forage.

Weeds a handicap. Weedy pastures may (1) hinder the growth of desirable forage plants, (2) lower the feeding value of the forage, and (3) impart objectionable flavors to the milk.

Pastures deplete fertility. Contrary to general opinion, even though pasture crops do have numerous advantages from the standpoint of soil conservation, as pointed out above, considerable amounts of fertility elements are removed from the soil through the grazing of pasture forage by dairy cows. For example, in the production of 4000 pounds of milk from an acre of pasture, there is removed in the milk as much nitrogen as that contained in 30 bushels of shelled

corn, as much phosphorus as that found in 25 bushels of shelled corn, and as much calcium as that removed in 850 bushels of shelled corn

Planning a pasture program. In most cases much thought is devoted each season to the production of the corn crop, including selection of the most suitable hybrid, preparation of the seedbed, and methods of planting and fertilizing, but little or no attention is given to planning the pasture program Many variations are possible in the kind of program which may be followed

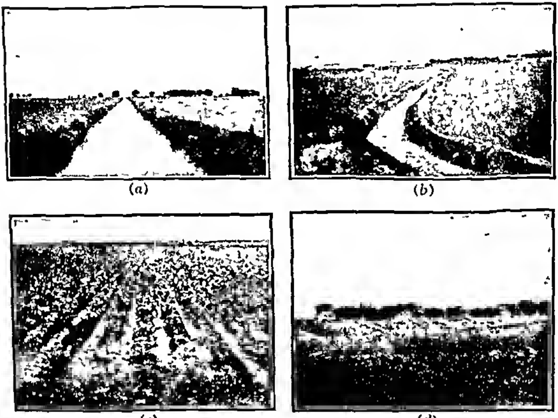
Long-lived pastures In most cases the amount of forage supplied by such pastures is relatively small unless special methods of fertilization and management are used Under good conditions of management, yields of 1500 to 2000 pounds of milk may be obtained from an acre of improved long-lived grass pastures Under poor conditions, such as occur on stony land impoverished soils, or woodlands, milk yields per acre may be 500 pounds or less

Rotation pastures The term rotation pastures refers to pastures which form a part of the crop rotation system For example, the system may be corn, 2 years, oats or barley, 1 year, meadow, 1 year, and pasture, 1 year On good soils receiving soil treatments as needed with liberal applications of barnyard manure, milk yields per acre of pasture may reach 3000 to 4000 pounds or, under excellent conditions, 5000 to 6000 pounds When yields as high as this are obtained, however, a part of the yield must be credited to the supplementary feeding of either grain mixture or roughage which is necessary to sustain the production of cows at a high level

Irrigated pastures In some areas where rainfall is less than the amount needed for the production of good pastures, irrigation has been found highly advantageous Even in sections where the yearly rainfall is usually ample for the growing of good grain crops the irrigation of pastures during intervals when rainfall is less than normal has been found practicable in some cases Yields as high as 8000 pounds of milk per acre have been reported for irrigated grass-legume pastures As mentioned above in connection with rotation pastures, the feeding of concentrates or other supplementary feed is usually responsible in part for high milk production during the pasture season

Designing a system of grazing The kind of pasture which can be obtained is determined to a large extent by the character of the soil, the climatic conditions, and the degree to which good management practices are carried out These conditions vary greatly in the various parts of the United States Regardless of the location of

a dairy farm, however, the operator should design a system of grazing which will (1) produce a large amount of forage, (2) provide a continuous supply of feed throughout the season, and (3) reduce supplementary feeding to a minimum. These goals often can be



(a) (b) (c) (d)

FIG. 24 1. In some areas, irrigation is an effective and practical means of increasing yields of meadows and pastures. (a) This main canal supplies water to a number of farms. (b) A large well supplies the water which traverses this alfalfa field to a neighboring field more than a quarter of a mile from the well. (c) A cultivated crop (sugar beets) grows rapidly when furnished water which flows between the rows (d) Spraying water from a light-weight movable pipe line is used in some cases for the irrigation of meadows and pastures

reached by the use of a number of different crops and fields on which pasture crops suitable to the region are being grown.

Southern states system. All-year grazing of pasture forages is often possible in some of the southern states when full advantage is taken of the wide variety of forage crops adapted to that region. Among the many crops which are used for pasture are kudzu, Dallis grass, hop clover, crimson clover, Bermuda grass, Bahia grass, lespedeza, soybeans, Sudan grass, Johnson grass, millet, and wild winter peas. Other crops which withstand colder temperatures than those

listed above and may also be grown successfully include red clover, white clover, orchard grass, and fescue

When adequate fertilization with lime and other plant foods is provided and the crops are grazed in rotation at the time they are at suitable stages, excellent pasturage may be provided for ten or more months of the year

Northern states system Dairy cattle, and especially milking cows, kept in the northern sections of the United States require protection from cold winds, cold rains, snows, and the low temperatures which are common to the area Further, most pasture crops require a rest period before cold weather sets in so that they may replenish and build up their stores of plant-food reserves Pastures which are grazed late in the autumn are usually slow in starting growth and low in yield in the following spring For these reasons the pasture *season in northern areas is relatively short, usually only* five to six months in length

In the corn-belt and north Atlantic regions dependence is placed upon long-lived grasses and legumes as the principal pasture crops Chief among the legumes are alfalfa, birdsfoot trefoil, the clovers (alsike, common or Dutch, white, Ladino, medium red, mammoth red, and sweet) Among the long-lived grasses in common use are bluegrass, bromegrass, tall fescue, orchard grass, redtop, and timothy On tillable land many of the lower yielding grass pastures, such as bluegrass and redtop, have been replaced by higher yielding grass-legume mixtures

Since pastures consisting of legumes alone do not provide suitable early spring grazing because of their watery condition and their tendency to cause bloat and other digestive disturbances, grass-legume mixtures are preferred Pure or nearly pure stands of alfalfa are often used for grazing after harvest of the early growth for hay or silage The grazing of the aftermath legume meadow crops is often the mainstay of the pasture program during the hot, dry weather of midsummer

A suitable pasture system for the southern part of the Corn Belt and areas having comparable climatic conditions is the use of a winter grain crop, such as winter rye, winter barley, or winter wheat, for early spring grazing The winter grain crops usually provide pasture for 2 or 3 weeks prior to the time grass-legume pastures are ready When hot weather arrives and growth of the pasture forage is slow, supplementary grazing may be provided by Sudan grass or a

mixture of this crop with soybeans. This pasture crop may be planted on the area which supplied the winter grain forage. When the crop is planted soon after the usual corn planting date, it is ready for grazing in about 6 weeks.

Improving pastures. No matter in what area of the country pasture improvement is to be undertaken, the procedures should follow

FIG. 24.2. In areas where winter grains thrive, early and luxurious pasture may be obtained by the use of winter rye, winter barley, or winter wheat.

a methodical pattern. On tillable land, one of the simplest and most effective ways of obtaining a more productive pasture is to plow the land and make a new seeding. Where conditions prevent plowing or make it inadvisable, improvement may be effected through renovation of the existing pasture. Before proceeding with an undertaking of such importance, obtain the recommendations of your county agent or state college of agriculture with regard to suitable pasture crops and mixtures, fertilizers to be used, methods of preparing the seedbed, and sowing the seed.

Select a suitable pasture crop. For most conditions, much higher yields of pasture forage are obtained from mixtures of grasses and legumes than from grasses alone. Legumes alone often are not suitable for early grazing because of their tendency to cause bloat, diarrhea, and off-flavors in milk. Improved strains of grasses and legumes which are high in yield and resistant to plant diseases are available. Not infrequently better results are obtained from a mixture containing two or more grasses in addition to one or more legumes than from one pasture crop alone. Wilt-resistant strains of alfalfa and, in the north Atlantic states and other areas to which it is adapted, birdsfoot trefoil are among the legumes which either are

relatively long-lived or reseed themselves Under suitable management, the annual lespedezas reseed themselves readily

Make soil tests No single procedure in establishing a pasture is more vital to the success of the undertaking than providing proper soil conditions and adequate amounts of plant food To be sure that these conditions are economically met, tests of the soil for acidity and available nitrogen, phosphorus, and potassium are necessary

FIG 213 Sudan grass pasture is one of the best means of providing green pasture forage in midsummer and early autumn It is best as a supplement to other pastures

In some areas, tests for boron or others of the minor elements may be desirable, particularly if alfalfa is to be sown Obtain directions for taking soil samples from your county agent or a commercial soil testing firm and submit the samples to a soil laboratory for testing

Apply needed treatments Lime is best applied 6 months or more in advance of seeding Nitrogen, phosphorus, and potassium fertilizers may be applied while the seedbed is being prepared and disked into the soil a few days in advance of seeding Sometimes fertilizers are applied in a narrow band 1 or 2 inches from the drill row of seed In this method, both seed and fertilizer are applied in one operation In making a summer seeding which follows a small grain, pasture, or other crop the use of a nitrogen fertilizer at rates of 100 to 150 pounds to the acre is especially advantageous in giving the new seedlings a quick start Boron fertilizers (borax) are usually applied several weeks after the new plants have become established

Prepare a good seedbed Spreading grass and legume seeds on the surface of an old pasture or on a poorly prepared seedbed is usually a waste of time and money Old sods should be thoroughly

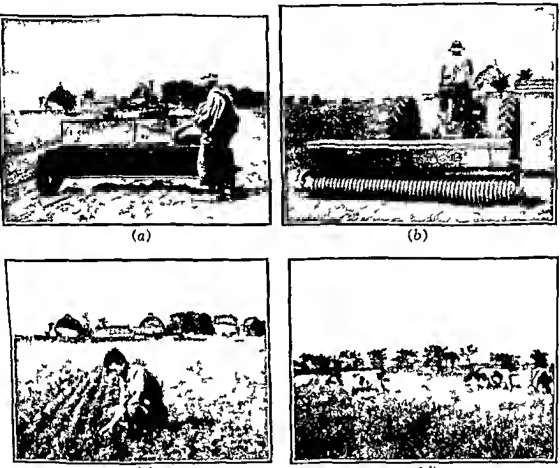


FIG 244 (a) An essential first procedure in the summer seeding of pasture mixtures is to ensure an ample supply of plant food (b) A well prepared seed bed is necessary to ensure an even distribution of seed and a shallow uniform covering of soil Picture taken August 20 (c) This picture which was taken on the same field 6 weeks later shows the rapid growth which resulted from the use of good methods together with the aid of fortuitous rains (d) A field seeded to an alfalfa Ladino clover and grass mixture on August 17 looked like this on May 4 of the following spring

torn up, either by plowing disking, and harrowing or on sloping fields where plowing is inadvisable, by means of field cultivators and harrows Smooth the surface using a corrugated roller if needed to break the lumps and work until it is fine and mellow Since most grass and legume seeds are best covered to a depth of not more than one fourth to one half inch, be sure that the seedbed is suitably prepared Further, if the field contains old sod delay seeding or

work the soil sufficiently to destroy the plants in this sod, lest the old grass renew its growth and choke out the new seedlings

Inoculate legumes In most cases the inoculation of legume seeds with the kind of inoculant required by the particular species is a profitable procedure It is one of the steps which aids in assuring success of the operation This procedure should be carried out just prior to seeding

Seed at proper season Obtain the recommendations of your county agent or state agricultural college with regard to the best time of year at which to make pasture seedings In areas where spring grains are grown meadow or pasture seedings are often made at the time the grain is sown In regions where winter grains are raised grasses are sometimes seeded in the fall at the time of seeding the grain and the legumes are broadcast on the field in late winter or early spring

For the southern part of the Corn Belt summer seeding without a nurse crop in August or early September has sometimes proven better than spring seeding Better control of weeds more uniform stands and a higher proportion of grasses in grass legume mixtures especially when Ladino clover is included are among the advantages of the summer seeding plan

Managing pastures Carefully managed pastures are usually more productive than those which are neglected The following procedures have been found advantageous for most dairy cattle pastures

Control grazing Permitting cattle or other livestock to graze pastures without restraint as to intensity of grazing or season of year is one of the most common causes of poor pastures Permit dairy cattle to go to pasture for the first grazing only after the forage has reached a height of 6 to 8 inches Remove cattle from pasture before the forage becomes badly overgrazed Keep all livestock off dairy cattle pastures during the winter and at times when the ground is so soft that the pasture may be injured by tramping

Practice rotational or alternate grazing Dividing the pasture into two or more fields and grazing these alternately or in rotation usually improves the appetizing qualities and yields of the forage Electric fences are sometimes employed as dividing lines In a few cases where forage is making a rapid rank growth an electric fence is advanced daily to permit access to only one day s supply of forage at a time This procedure helps to reduce to a minimum the amounts of forage spoiled by tramping

Fertilize pastures Proper fertilization is one of the most effective of all procedures in pasture improvement As pointed out earlier in this chapter, the fertility level in a pasture declines unless methodical procedures are followed for preventing this from occurring Make liberal applications of barnyard manure up to 3 to 4 weeks before grazing, apply commercial fertilizer freely in early spring, and continue the use of a high proportion of legumes in the pasture forage in order to maintain the nitrogen content of the soil Spread cattle droppings on a closely grazed pasture using a harrow to destroy fly breeding places and to permit grass to grow on these spots

The fertilization of pastures has numerous advantages in addition to increasing the yields of forage Fertilization makes possible (1) the introduction of highly nutritious forage plants, e g , legumes, (2) the elimination of less desirable species of pasture plants, and (3) an increase in the individual plants of such mineral nutrients as calcium, phosphorus, and cobalt

Control weeds Prevent weeds from maturing their seed by clipping the pasture (with the sickle bar set high) two or three times during the season Small areas of Canada thistles or other weeds which are difficult to control may require spraying with a herbicide or frequent plowing and continuous fallowing of those areas

Guard animal health Before turning dairy cattle into a pasture consisting of luxuriant green forage for the first time after the winter feeding period has ended or after more than several days' absence from pasture feeding, give the animals a full feeding of silage or hay In grazing Sudan grass pasture, cattle should not be permitted access to it until the grass has reached a height of at least 18 inches It is well to test the safety of Sudan grass, that is, the absence of toxic amounts of prussic acid, by first turning into the field one or two of the least valuable animals and permitting them to graze for 2 hours If no untoward effects are noted during that period of time, safety of the pasture may be assumed It is a good practice to remove cattle from Sudan grass pasture during a severe drouth and following heavy frosts

Protect pastures during dormant periods Discontinue the use of pastures early enough in the fall to permit the plants to store reserves through a vigorous new growth before winter Leave this growth to act as a cover Spread a light covering of barnyard manure to serve as a further protection against heaving caused by alternate freezing

and thawing Keep all livestock off pasture during the winter season and also during periods of hot, dry weather in summer when the pasture is dormant and no growth is taking place Exceptions to the winter grazing rules occur in the southern states and other areas where pastures are especially grown for winter use

Investigations at the Wisconsin Agricultural Experiment Station indicate that winter survival of alfalfa in northern areas can be markedly promoted by maintaining in the soil high levels of lime and available phosphorus and potassium, particularly the latter[1]

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REVIEW

1 List and discuss fully seven advantages of pasture as forage for dairy cattle

2 What are the disadvantages of pasture? Explain each of these

3 Explain what is meant by the terms long-lived pastures rotation pastures, and irrigated pastures How large a yield of milk may be expected from each of these kinds of pasture?

[1] Wang, L C et al Effect of Lime and Fertility Levels on the Chemical Composition and Winter Survival of Alfalfa Agron J, *45* 381–4, 1953

4 What forage crops may be utilized in a system of grazing suitable for the southern states?

5 List the principal factors to be observed in designing a system of grazing for the northern states

6 Give detailed step-by-step directions for improving pastures through reseeding, explaining the reason for each step

7 List and discuss six management procedures which will aid in maintaining the yields of pastures at a high level

25

Making High-Quality Hay for Dairy Cattle

Improvement in the kind and quality of roughages fed to dairy cattle offers probably the greatest single opportunity for betterment of dairy farm practices and dairy feeding programs Careful investigations by agricultural experiment stations and the teachings of agricultural high schools, agricultural colleges, and the farm press have brought about reasonably good practice in the feeding of grain mixtures to dairy cattle, but there still remains a vast field for improvement in the nature of the roughage portion of the ration

During the last half century, thousands of acres of non-legume hay crops have been replaced with legume or grass-legume crops, but until recent years little or no improvement in methods of making hay has taken place Notable experiments which have led to further research and revolutionary changes in haymaking methods were under way at the beginning of World War II The shortage and expense of farm labor during and following the war period created a strong demand for labor-saving machinery for making hay Now new machinery and new storage methods, as well as increased knowledge of nutritive factors furnished by well cured hay, have opened a new era in haymaking As a result of the discovery of new methods of making silage from grasses and legumes, many acres of meadow crops are now made into silage instead of being cured as hay These changes for the most part are in the interests of improved feeding practices and better soil conservation, and thus tend to make dairy farming a more enduring and a more profitable phase of agriculture

Learning the value of hay as a feed Hay is the most important winter feed of dairy cattle in the United States, as well as in a number of other countries Some of the reasons for this are explained in the sections which follow

Hay chief source of TDN Hay is one of the chief sources of total digestible nutrients in the feeding of dairy cattle during the winter

feeding period. On farms of persons who regularly report certain facts concerning their herds to the U. S. Department of Agriculture, hay is fed on about 97 per cent of the farms while silage is fed on only one-third.[1] The reports cover the October to May, inclusive, winter period.

The amounts of hay fed per cow are influenced by the length of the barn-feeding period and the availability of winter grazing. In

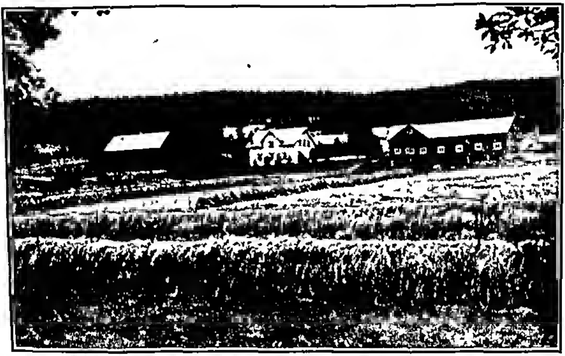


Fig 25 1 Haymaking is a difficult procedure where climates are cool and humid This scene shows hay being cured on wire fences, a common method of haymaking in Norway (Courtesy, Doctor Knut Breirem, Royal Agricultural College of Norway.)

North Dakota and Utah, for example, 3 8 tons of hay per milk cow were fed in herds of dairy reporters, while in Alabama, Mississippi, and Louisiana, the amounts ranged from 0 6 to 0 8 ton per head. The average for the United States as a whole was 2 3 tons per cow.[1] The amount of TDN supplied by 2 3 tons of hay of average feeding value is sufficient to maintain a cow weighing 1200 pounds for a barn-feeding period of 8 months. Additional feed (silage or grain mixture, or both) would be needed to furnish nutrients for milk production. For the winter feeding of low-producing cows, hay may furnish more nutrients than any other single feed. For high-producing cows, hay may furnish one-third to one-half of the TDN requirement.

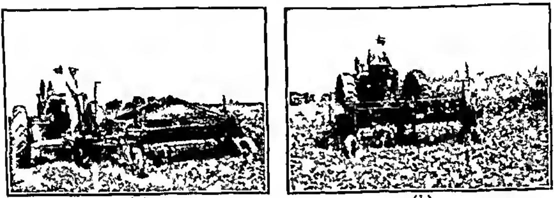
[1] Rations Fed to Milk Cows Bur Agr. Econ , U.S.D.A , 1952

Legume hays provide protein Legume hays as a class contain from two to five times as much digestible protein as do non legume hays (Table 8 1) Opportunity is afforded through the feeding of legume hays to supply much of the protein needed in the ration Table 8 1 shows that alfalfa hay contains about one fourth as much digestible protein as do the well known protein feeds such as cotton seed meal linseed meal and soybean meal Hence if a cow being fed alfalfa hay can be induced to eat 4 *extra* pounds of hay this quantity of hay might replace 1 pound of high protein feed included in her grain mixture In numerous cases dairy farmers have made use of this knowledge and have thereby brought about several improvements in their farm program namely (1) the growing and feeding of more legume hay with resultant betterment of soil conditions (2) a reduction in the amount of purchased feed and thus less cash outlay (3) an improvement in the character of the ration because of a higher intake of carotene and other nutritive factors and (4) improved pastures when grazing follows haymaking either in the same season or in succeeding years

Legume hays high in yield Some of the legumes are greatly superior to the non legumes as hay crops because of their higher yield of protein Some of them also produce more TDN per acre than do the non legume hays For example alfalfa is outstanding in its yield of protein since it yields more of this essential constituent than any other commonly grown feed crop (Table 8 1) Alfalfa is also rated high as a producer of TDN being higher than most other hay crops and nearly equal to corn silage in this respect

Legume hays high in calcium and carotene The value of legume hays in sustaining milk yields at high levels is in no small measure attributable to the large amounts of calcium carotene and possibly other desirable nutritive factors which these hays furnish Legume hays as a class contain from two to five times as much calcium as do the non legume hays (Table 8 1) and legume hays generally are superior to non legume hays as a source of carotene (Table 8 3) While there is not as wide a difference as might be expected in the average carotene contents of legume and non legume hays under average conditions it is evident from the table that under good curing conditions it is possible to produce legume hay with a relatively high carotene value Carotene is gradually destroyed by oxidation The carotene content of hay in spring may be only one fourth as much as it was when the hay was stored at harvest time

The estimated carotene requirement for the maintenance of a 1200 pound cow is 72 milligrams daily, with an additional allowance of 30 milligrams daily during the last 2 to 3 months of gestation. Assuming a total requirement of 102 milligrams daily it may be calculated from Table 8 3 that about 25 pounds of bleached legume hay, or the same quantity of good non legume hay would be needed to ensure an adequate supply of this substance. Corn and sorghum silages are relatively poor sources of carotene containing 2 to 10 mg per pound. Grass and legume silages however have a carotene value



(a) (b)

Fig 25.2 Crushing coarse stemmed hay between steel rollers at the time it is mowed hastens the curing process provided weather conditions are favorable (a) This device crushes the cut crop immediately after it leaves the sickle bar (b) With this machine the swath cut on the previous round is crushed

of 15 to 25 mg per pound. The grains, except yellow corn and its by-products are nearly devoid of carotene. Hence, it is especially important when hay is the only or the principal roughage fed during the barn feeding season that it be a good source of carotene.

Selecting hay crop suitable to farm. Improved varieties of well known species and several recently introduced species of grasses and legumes which are especially useful as hay crops are now available. Select the ones best suited to the conditions on your farm. It is possible that some legume crop not now grown in your locality might do well if the necessary soil treatments were applied. The area over which alfalfa is grown has been expanded through the application of suitable soil treatments and the use of resistant and hardy varieties adapted to the region. Strains of alfalfa have been developed which are suitable for many different sections of the United States, including dry sandy soils.

In northern regions farms that have stony or poorly drained soils usually must depend upon grass crops rather than upon alfalfa or

other legumes The cropping system, too, must be considered When meadows are to be used later for pasture it is often found that a grass-legume mixture is better than a single crop Under irrigation,

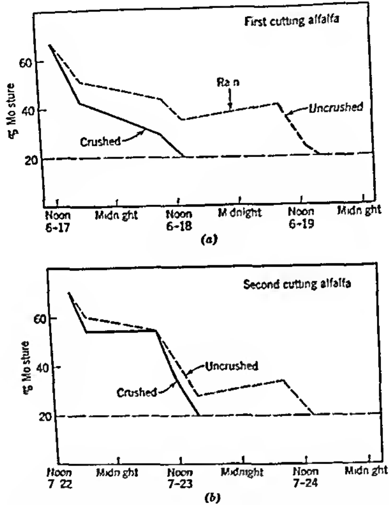


Fig 253 These charts show the results of an experiment in which it was found that the crushed crop cured more rapidly than the uncrushed (Cir 693 Ill Agr Exp Sta)

alfalfa seems to be the preferred crop for hay because of its ability to produce high yields throughout the growing season

Harvesting hay to retain highest quality Since practically all the carotene is provided for dairy cattle by the roughage, it is important that hay be cured with the retention of as much as possible of its natural green color The following procedures describe methods

of haymaking which aid in retaining this green color and in producing hay having high feeding value

Harvest crop at proper stage Proper stage for harvest is determined by a number of factors, including (1) stage at which the highest quality of product is obtained, (2) stage which gives the greatest yield, (3) effect upon the succeeding crop

As a rule, harvesting at an early stage of development of the crop gives a higher content of protein and carotene and less fiber than late harvesting Not only is the protein content higher in early cut crops, but also the digestibility of the protein is higher The digestibility of the fiber decreases as the plant approaches maturity

A common rule for harvesting alfalfa is to cut when the plants have reached the tenth-bloom stage Red clover and alsike clover are commonly harvested at too advanced a stage for best-quality hay The rule usually followed is to wait until one-third or more of the heads are brown, but harvesting in early bloom or in full bloom may yield hay nearly as high in protein content as alfalfa, whereas, under the common procedure, the protein content of these clover hays is much less Moreover, there is a much smaller wastage of coarse stems when early cut clover hay is fed Alsike clover is best harvested at the full-bloom stage

Ladino clover offers special problems in haymaking because of its high moisture content (80 to 85 per cent) and low, spreading growth habit Ladino clover in pure stand tends to mat and later to mildew, thus making hay of poor quality For this reason, plant grass with the clover so that 40 to 60 per cent of the mixture is grass

Cut Ladino for hay when about one tenth of the heads have turned brown The portion of the plant harvested consists mostly of leaves and leaf stems, thus requiring careful handling to prevent severe losses through the shattering of leaves When carefully cured with full retention of leaves, the hay is fine and leafy and exceptionally high in protein content

The first year's sweet clover crop makes better hay than the second year's growth It should be harvested in late fall to avoid injury to the plants

Soybeans make the best quality of hay when harvested while the leaves are still green and before the seed has reached more than one-half normal size However, at this stage there is a sacrifice in the yield per acre of the soybean crop

Grasses like timothy and redtop are usually harvested at too advanced a stage for high-quality hay Often these are not cut until

after all blooms have fallen, but hay much superior in protein content and in palatability can be made by harvesting timothy before bloom or in early bloom. Redtop should be cut when the heads first appear above the boot. Oats and wheat are ready for hay harvest when the grain is in the milk stage.

Use the stage of development of the legume portion of grass-legume mixtures as a guide to the time to harvest, since the stage at which legumes are cut is likely to have a greater effect upon succeeding harvests than it has with the grasses.

Cure rapidly. Once the crop has been cut, use every possible means to speed the curing process. With delayed curing, there is possibility of loss of nutrients in the hay through (1) continued respiration of the plant cells; (2) leaching by rain and dew; and (3) mechanical losses occasioned by much turning of windrows which have become damp. Use as many of the following procedures as are suited to your conditions to hasten curing.

CRUSH THE STEMS. Hay crushers are machines which are used at mowing time to pick up the newly cut crop from the swath and pass it between two steel rollers. The process cracks the stems lengthwise but does not squeeze out the plant juices Crushing and mowing are usually done with a tractor in one operation, the crop being cut by a sickle bar to the right of the tractor and the crushing being done by the crusher which is drawn behind the tractor. The crusher thus picks up the swath which has been mowed on the previous round.

Crushing coarse-stemmed hays reduces the length of the curing time in the field. This means that sometimes hay may be stored a day earlier than if it were not crushed. At the New York (Cornell) Station (Memoir 310), crushing saved from 1½ to 4½ hours of curing time. The Mississippi Station (Cir. 137) found that crushing was especially useful in making hay from Sudan grass, Johnson grass, and soybeans.

WINDROW EARLY. Hay completely cured in the swath is subject to leaching and discoloration by dew and rain. In addition, in hot weather, there is likely to be a heavy loss of leaves and the production of hard, wiry stems. Therefore, windrow the hay as soon as the legume leaves in the upper part of the swath show signs of shattering. In harvesting a light legume crop in hot, dry weather, it may be best to use a windrow attachment on the mower. This device cuts and windrows the crop in one operation.

Under New York conditions (N. Y. Cornell Memoir 310) there was no advantage in making windrows from a single swath as compared

with two swaths, and making windrows from four swaths rather than from two added 25 per cent to the curing time

TURN WINDROW FREQUENTLY To hasten curing, turn large or damp windrows often As soon as the weather has cleared after a rainstorm, turn or ted the windrows in order to shake out the clinging drops of water and repeat as often as needed Also turn windrows frequently when the ground is damp so that the under side of the windrow will be exposed to sun and air currents

Turning is best done with a side-delivery rake Following a rain, it may be best to reverse the rake and use it as a tedder in order to shake up the hay Loosening of the hay in the windrow may also be done with a special machine which "fluffs" the hay

Cure thoroughly in field As a rule, hay which is to be stored in the loft, or mow, of an ordinary barn must have not more than 20 per cent moisture if it is to become good-quality hay With a high moisture content at time of storage, high temperatures usually occur, causing brown or even blackened hay Excessive losses may occur in such hay, sometimes amounting to as much as 40 per cent of the dry matter of the hay as stored (J Agr Research, *18* 299–304) Normal losses in haymaking from the time of storing until feeding should not exceed 12 to 25 per cent of the dry matter (W Va Bul 332) A high moisture content in stored hay may also lead to spontaneous combustion, as discussed later in this chapter As a rule, when the moisture content at time of storage is 30 per cent or more, either molding occurs or a mustiness develops When this hay is removed from the mow, it is usually very dusty Brown, moldy, and musty hay are lower in carotene content and in palatability than properly cured hay that is high in green color

Experience is needed in determining when the stage of 20 per cent moisture is reached To aid in learning the character of hay at this stage, dry several samples, one at a time in an oven overnight To facilitate drying use shears and cut the hay into pieces 2 or 3 inches in length Spread in a thin layer in baking pans Be careful to keep the temperature low enough to prevent charring of the sample (not over 225° F) A sample containing 20 per cent moisture should lose exactly one fifth In other words a 4-pound sample after drying should weigh 3 2 pounds If the loss is more than this the hay is too high in moisture to make the best-quality hay

Store in best manner Several different methods of handling and storing hay are in use, including (1) storing loose in mow, (2) storing loose in stack, (3) baling in field, (4) chopping at barn or in field

STORING LOOSE IN MOW This method is adapted to farms of all sizes A minimum amount of haying equipment is needed but of course a considerable investment in buildings is involved The usual equipment consists of mower, side-delivery rake, hay loader, and unloading equipment consisting of either hay fork or hay slings The use of hay slings saves much time as compared with the hay fork method

As soon as the hay is dropped into the maw from the fork or slings it should be spread by hand to facilitate uniform drying and to make easier its removal at feeding time The addition of salt increases the appetizing qualities and the amount consumed, but it has little or no beneficial effect on curing

The arduous labor involved in storing hay loose in maws and the improved financial position of farmers in recent years has caused a decline in this method of harvesting Machine methods are replacing the hand labor used in making hay

STORING LOOSE IN STACK Stacking in the field is a time saving operation for the rapid storing of hay A number of different kinds of stackers are in use As a rule hay containing somewhat more than 20 per cent moisture may safely be stacked provided the stack is not large For large stacks it is best to keep the moisture content at a level close to 20 per cent Field stacking is one of the simplest and most certain methods of producing high-quality hay This method finds special favor in regions of low rainfall

To prevent excessive loss by weathering especially in the case of non grass hays like alfalfa hay and clover hay, cover the stacks with one or more loads of spoiled grass hay, or weeds, or apply a temporary cover Such covers are rarely used in dry regions

BALING IN THE FIELD The use of the pick up baler for baling hay directly from the windrow saves much hand labor as compared with storing loose in the mow Often the quality of the hay is poorer, however Pick up balers involve a considerable investment and in many cases are owned by commercial operators who must use them as much as possible in order to realize a satisfactory return on their investment For this reason hay is often baled before it is properly cured or when damp from dew or rain In storing damp hay, care must be taken so that mustiness or mold does not develop Often baled hay becomes a total loss because of mold

Field baled hay may be stored in the mow of a barn or under an open shed Sometimes baled hay is placed in ricks at the side of the field and temporary covers provided When hay is baled in the field and stored where it is well ventilated such as under an open

shed, it may safely contain somewhat more than 20 per cent moisture at the time of baling. Proper storage of field-baled hay consists of ricking the bales on edge and leaving a few inches of space between the tiers of the bales. If the tiers are more than four bales high, they should be crosstied, that is, some of the bales should be placed crosswise to prevent their tipping or settling against each other.

A common practice in the harvesting of hay by the baling method is to leave the bales in the field for a few days to permit thorough curing before storing under cover. This procedure seems to be an excellent one for dry regions but when followed in humid areas often leads to disastrous results because of unexpected rainstorms.

There has been a marked increase in the use of the pick-up baler for the harvesting of hay. In 1945, 24 per cent of the hay fed to milk cows in herds kept by dairy reporters was fed as baled hay but in 1952 the figure had risen to 53 per cent. In the western states where half of the hay fed to milk cows is purchased, it would be expected that much of the hay would be baled in order to facilitate transportation. The tendency toward baling, however, is not confined to districts having large commercial herds. In four of the leading dairy states in which less than 10 per cent of the hay fed to milk cows is purchased, the percentages of baled hay fed to milk cows in herds of dairy reporters for the years 1945 and 1952 were as follows: New York, 20 and 55; Michigan, 8 and 44; Minnesota, 6 and 41; and Wisconsin, 3 and 29.[1]

CHOPPING AT BARN OR IN FIELD. Some farmers prefer to store hay in chopped form. The advantages of this method, as compared with storing long or uncut hay are: (1) a saving in storage space, since chopped hay occupies about half as much cubic space per ton; (2) greater convenience and a saving of labor in feeding; (3) less hay refused by the cattle; (4) with some types of harvesting machines, much less labor in harvesting and storing.

The equipment used for chopping hay may be silo fillers or specially built hay choppers which are stationed at the barn or other storage place and which blow the chopped hay into the loft or storage bin. Forage harvesters which pick up the cured hay from the windrow, chop it, and elevate it into a trailer wagon or truck in one operation are finding wide use in haymaking. Such equipment makes the harvesting of hay almost entirely mechanical and makes it possible to handle a large tonnage of hay daily with a crew of two or three men.

[1] Rations Fed to Milk Cows. Bur. Agr. Econ., U.S.D.A., 1952.

Successful storing of chopped hay necessitates thorough curing in the field to a moisture content of 20 per cent or less, because chopped hay packs closely and is likely to become brown or moldy unless thoroughly dry

Ventilate hay storage Soon after hay is placed in a mow, stack, or bale it goes into a "sweat," or fermentation process The temperature rises and moisture is given off The sweating process may

(a) (b)

FIG 254 Drying hay with heat from portable crop driers is an effective aid to curing especially in humid weather (a) In this picture a stack of baled hay is being dried A canvas duct conveys the air from the drier to a tunnel built of bales lengthwise of the stack (b) The air from this drier is blown into an A frame which extends nearly the full length of the building The hay was chopped in the field and blown into the building the same day it was mowed

last from a few days to three or four weeks, depending upon the amount of moisture in the hay, the tightness of packing, and the facilities for ventilating the hay Hay in tightly closed hay mows and large stacks remains in a sweat for a longer time than when facilities are provided for a ready escape of moisture Hence it is desirable, as a rule, to use all available means at hand to promote rapid drying of the stored hay

In storing hay in a mow, it is best to spread the hay over the entire area of the mow rather than to fill one bent or one end of the mow at a time Doors and windows should be kept open to provide ventilation

In stacking hay, stacks are best made not more than 12 feet in width and rectangular in shape In making such a stack, lay out the bottom about 10 feet in width and, when 2 or 3 feet above the ground, widen to 12 or 13 feet to form a drip, or eaves Then gradually draw in the sides and bring to a top not over 4 or 5 feet in width Natural ventilation usually occurs in properly built stacks

Special means of ventilating hay mows and chopped hay storage bins may be provided. The installation in hay mows of a number of simple vertical vents 2 by 2 feet to 4 by 4 feet in cross section and constructed of wood slats has been found to aid considerably in promoting rapid drying. In constructing metal storage bins, or "hay keepers," vents or ducts are usually built into the walls, or a ventilating duct 3 or more feet in diameter may be built in the center of

Table 25.1. *Proportion of Feed Nutrients Present in Alfalfa* 6 *Months after Harvesting by Four Different Methods* *

Method of Harvesting	No. of Harvests	Dry Matter, %	Protein, %	Carotene, %
Hay field-cured:				
Rain-damaged	2	63	55	0.6
Not rain-damaged	3	76	69	2.7
Hay dried by forced ventilation:				
Natural air	3	83	79	7.8
Natural air with supplemental heat	5	86	80	11.8
Dehydrated hay	4	90	79	23.6
Wilted silage	5	83	83	20.3

* Davis, Roy B., et al. Drying Forage by Forced Ventilation. Farmers' Bul. 2028. U.S.D.A.

the structure. Some of the specially designed metal hay storage units have motor-driven fans for forcing air through the chopped hay.

A forced draft-ventilation system in which only outside air is used as the drying medium was developed by the Tennessee Agricultural Experiment Station and the Tennessee Valley Authority. In this plan, a series of wooden ducts, or flues, is built on the floor of the hay mow with openings next to the floor. Outside air is forced through the system at a rapid rate by a power-driven fan and is forced upward through the hay. When a barn is provided with this equipment, it is possible to store hay having up to 35 per cent moisture (in good drying weather up to 45 per cent moisture) and to dry it into high-quality hay at a low cost of operation.

The advantages of this plan may be summed up as follows: (1) hay may be taken from the field much sooner than when it remains in the field to reach a 20 per cent moisture content, thus helping to avoid loss by rains; (2) handling the hay when it has a high moisture content prevents shattering of the leaves; (3) the carotene content is well preserved (Table 25.1). The adoption of this method on many

farms has proven to be an important contribution to modern methods of haymaking It was made possible in part by the wider use of electricity on farms Since the designs for these systems have undergone many changes, consult your agricultural experiment station power company, or county agent for plans to fit your particular barn

Artificial drying (dehydration) of freshly harvested hay is employed commercially in the making of alfalfa meal and on a few

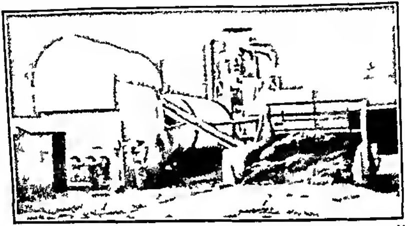


FIG 25.5 A quick-drying process (dehydration) of freshly harvested alfalfa is a large commercial business The chopped crop is dried ground and sacked within a few minutes after the forage enters the drier

large specialized farms An important advantage of this method is that the hay is cured with little loss of carotene (Table 25 1), but a disadvantage is that vitamin D is not enhanced through exposure to the sun as is hay cured in the field The method is useful in humid regions where haymaking by ordinary methods is hazardous Present equipment for artificial drying involves a large investment in machinery, and the cost of power and fuel for each ton of hay dried is too great for most farms The method at present is confined chiefly to areas where large acreages of alfalfa are readily accessible (usually 500 acres or more for one drying unit), and where high yields are ensured either because of ample rainfall or through irrigation

Avoiding spontaneous combustion Newly made hay undergoes fermentation with the production of heat Hay with a high moisture content usually becomes hotter than does well cured hay When high moisture hay is stored in a poorly ventilated mow, the tem

perature may continue to rise for several weeks. Temperatures may reach 300° to 400° F. Sometimes gases are formed, and these may catch fire with explosive violence. Under such conditions, it is usually impossible to save either the hay or the building from complete destruction.

Preventive measures consist in (1) curing the hay well before storage; (2) providing good ventilation in the mow by means of open windows and doors, vertical ventilating shafts, or forced ventilation through a drying system; (3) spacing tiers of bales to provide air spaces of 2 to 3 inches between tiers; (4) stacking bales on edge. After fermentation has subsided, close doors and windows to prevent rain from entering.

Using "preservatives" not satisfactory. Extensive tests at Cornell University of commercial compounds which were claimed to prevent molding in high-moisture hay showed that none of the compounds tested were effective.[1] Some of the compounds had as a principal ingredient sodium bicarbonate (baking soda), which presumably releases enough carbon dioxide to prevent mold growth. While pure carbon dioxide does inhibit development of mold, there is always present in an ordinary hay mow enough oxygen mixed with the carbon dioxide to permit the mold organisms to grow. The investigators found only two practical procedures for treating high-moisture hay, namely, either thorough field curing or mechanical drying.

Grading hay before sale. Hay sold at the principal hay markets is graded before sale by inspectors under the supervision of the Production and Marketing Administration of the U. S. Department of Agriculture. The chief factors which enter into the grade designation are percentages of (1) leaves, (2) green color, and (3) foreign matter, as well as other considerations, such as whether or not the leaves cling to the stems. Alfalfa hay which is graded No. 1 must have a minimum of 40 per cent leaves; No. 2 grade, 25 per cent; and No. 3 grade, 10 per cent When the hay has 50 per cent or more of leaves and most of the leaves cling to the stems, the words "extra leafy" are used in the grade designation, and when the hay contains 75 per cent or more green color the term "extra green" is added. The highest grade designation for alfalfa hay is "U. S. No 1 Extra Leafy, Extra Green Alfalfa Hay." Hay containing some moldy bales or moldy spots, or having more than the allowable percentage of weeds

[1] Kennedy, W. K, et al It Doesn't Pay to Use Hay and Grain Preservatives Hoard's Dairyman, *98*.639, 1953

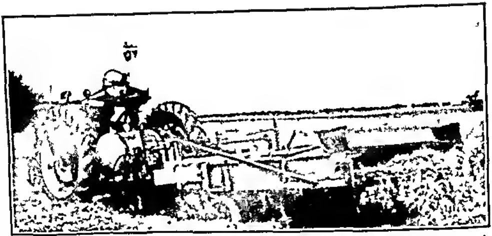


FIG 25 6 New developments in haymaking are still possible This experimental machine heats the cut crop as it comes from sickle bar and crusher, the object being rapid drying and retention of a high proportion of the carotene content

or other foreign matter is graded as "Sample Grade" Grades are also assigned to hay other than alfalfa and to mixed hay, allowances being made for the characteristics of each species of crop.

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REVIEW

1 Give detailed facts supporting the statement that hay is an important source of total digestible nutrients for dairy cattle

2 Explain the value of legume hays in supplying protein to dairy cows

3 Compare legume hay crops with non-legume crops in yield of nutrients to the acre

4 Discuss the value of legume hays as suppliers of calcium and carotene for dairy cows

5 Why should one select a hay crop which is best suited to his own farm?

6 Give reasons for the recommendation that a hay crop should be harvested at the proper stage, and make recommendations for the best stage of harvest for leading hay crops

7 Explain the various procedures which may be used to hasten the curing process, and point out their value

8 Discuss the different procedures for curing hay in the field What percentage of moisture should be reached before storage?

9 Discuss the merits of (*a*) storing loose in stack (*b*) storing loose in mow, (*c*) baling in field, and (*d*) chopping in field or at barn

10 Point out how hay mows or other storage units may be ventilated under ordinary conditions and by means of forced ventilation

11 How may spontaneous combustion be avoided?

12 Explain the grading of hay

26

Making High-Quality Silage for Dairy Cattle

Silage is fed to about 30 per cent of the milk cows kept by farmers who make reports on their dairy operations to the U S Department of Agriculture[1] The amount of silage fed per milk cow ranges from less than 1 ton in the south central states to 3 tons in the north Atlantic states In Connecticut, Rhode Island Massachusetts, and Wisconsin, silage comprises a relatively large part of the roughage, the amount fed being about 3 75 tons per cow In terms of dry matter in roughage fed by dairy reporters in all states to their milk cows during the October to May winter-feeding period, silage contributes about one-fifth of the total roughage

Numerous crops used as silage For many years, corn has been the most popular silage crop, since it can be grown for this purpose to advantage in most of the states having large numbers of milk cows During the period 1944–49, 86 per cent of the dairy reporters fed corn silage to their herds, but since that time the percentage of reporters feeding corn silage has declined to less than 75 per cent[1] The decline is accounted for by a sharp increase in the use of grass silage During the 1944–49 period, only 3 per cent of the reporters fed grass silage to their herds, but this percentage has climbed rapidly The availability of forage harvesters, trailer wagons, and other silagemaking machinery, together with the dissemination of the results of research by experiment stations, have helped to popularize grass silage The states of Washington, Ohio, and Delaware are leaders in the use of grass silage, while the north Atlantic states as a group have greatly expanded their feeding of this kind of silage

Choosing suitable silage crop A number of considerations enter into the choice of a crop for silage Study the directions for making silage from various crops as *given in this* chapter before deciding upon the adoption of a particular silage crop or a change in your cropping system

[1] Rations Fed to Milk Cows Bur Agron Econ U.S.D.A 1952

Yields of nutrients vary In the corn-belt states and in other areas where corn yields well, more total digestible nutrients per acre are obtained from corn harvested as silage than from most other crops (Table 26 1) However, corn is a low-protein crop is soil depleting, and is costly to grow where much fertilizer is needed The table shows that a number of legume crops yield more digestible protein than does corn

Table 26 1 Yields of Nutrients from Silage Crops

Crop	Yield per Acre *		Digestible Protein per Acre		Total Digestible Nutrients per Acre	
	Hay tons	Silage tons	Hay, lb	Silage, lb †	Hay, lb	Silage, lb †
Corn		9 0		220		3270
Sorghum, sweet		10 0		160		3110
Alfalfa	2 2	7 9	460	510	2210	2220
Soybeans	1 4	5 0	270	295	1370	1400
Clover, red	1 3 ‡	4 7 ‡	185	250	1360	1420
Clover, sweet	1 2	4 3	225	300	1140	1230
Grains cut green	1 0	3 6	80 §	145 §	960 §	1020 §
Cowpeas	1 0	3 6	245	205	1030	970

* Based on yields given by Crops and Markets U S D A
† Calculated from chemical composition of green roughages
‡ Yield of clover and timothy
§ Average of barley oats and rye

Weather conditions influence choice In parts of the Southwest, the sorghums are better adapted than corn to withstand climatic conditions and for this reason are extensively utilized as silage crops The states of Kansas and Missouri are leaders in the use of sorghum silage In some of the semiarid regions of the Northwest, where both low rainfall and early frost are factors, sunflowers have found use as silage Thus the choice of a crop for silage is greatly influenced by climatic conditions

Not infrequently, at the time of making the first cutting of meadow crops for hay, the weather is so rainy and cool that making good-quality hay is extremely difficult Besides, much hay is entirely spoiled Under such conditions, making silage from grass and legume meadow crops may be a means not only of saving the entire crop, but of making silage considerably higher in protein and carotene content than corn silage In some years it may be desirable to ensile the first

cutting from the meadow for summer feeding and in the fall to refill the silo with corn for winter use

Availability of equipment a factor Unless a forage harvester which picks up and chops the crop in one operation is used, the amount of labor involved in ensiling meadow crops is large and probably greater than the amount required for haymaking From 3½ to 4 tons of green crop are required to make 1 ton of well cured hay Thus the weight of crop handled is much greater when ensiled than when harvested as hay

Fig 26 1 Corn is the principal silage crop in the United States Fertilization has a profound effect upon the yields of corn forage as well as upon the yields of corn grain Left unfertilized right fertilized

Preparing satisfactory silo Well made silage will keep in good condition for feeding over a period of many years if it is stored in a well constructed silo On the other hand losses of 20 to 40 per cent of the dry matter of the forage ensiled may occur when it is poorly stored

Exclude air, rain and animals Silage is produced when a forage crop which contains suitable amounts of moisture and fermentable carbohydrates undergoes a characteristic fermentation process under conditions in which outside air is excluded The fermentation process normally continues for 2 to 3 weeks Acids chiefly lactic and acetic are produced in quantities up to 2 per cent by weight of the fresh silage As long as air and other factors which may affect the silage are kept out the silage remains in good condition sometimes over a period of several years

The first and most important consideration in making good silage is to exclude the air Use a well constructed cylindrical silo whenever costs permit A circular silo is more readily reinforced than a rectangular one and is not so likely to warp or twist The development of cracks or bulging of the walls may let in air The entrance

of air into silage permits the growth of molds and other microorganisms that cause mold and decay. Durable silos are built of concrete, tile, brick, wood, stone, or glass-coated steel. Where building costs must be kept low, silos of a temporary nature, such as trench silos or slatted-fence silos, may be satisfactorily used. Regardless of the type of silo, provide a roof on the silo or a covering over the silage in order to exclude rain, snow, and birds, and to reduce freezing in winter. Upright silos built of durable materials and provided

Fig 26.2. Sorghums form the chief silage crop in the Southwest In this Illinois field varieties of sorghum were grown for comparison of their forage yields

with roofs meet these requirements and, in addition, help to keep out rodents and insects.

Peavines are usually made into silage at the viners by building them into compact, rectangular stacks. The stack method is sometimes used for other crops also. A layer ½ to 2 feet in thickness on the outside of the stack decays and forms a seal which protects the inner portions. It is not customary to cover stack silage completely, although in some cases waterproof coverings held in place by agricultural limestone or other weights have reduced spoilage. The stack method is adapted to conditions where a large amount of low-cost forage is available, and it is not necessary to employ methods of ensiling which will save the highest possible proportion of it. The spoiled portions of stack silage are easily utilized as manure.

Provide good drainage. Locate trench, pit, semipit, and slatted-fence silos on sloping land, and construct a ditch sufficient to carry

away all rain water When rain water seeps into the lower part of a silo, it is likely to cause the silage to become soggy and unappetizing Stock may refuse such silage

Upright silos made of durable materials may not need outside drainage but may require an outlet for surplus juices if high-moisture crops are ensiled While a floor sloping toward the center of the silo with a tile drain leading from a grating in the floor may provide some drainage, a more rapid draining of the juices can be obtained by making the floor high in the center with grooves leading to several outlets in the outside wall Place stoppers in these outlets after drainage has ceased to prevent the entrance of rodents and insects

Clean silo before filling Sweep down any silage or filth clinging to the walls and clean the floor before commencing to fill the silo Cleaning the silo helps to reveal places which are in need of repair

See that silo is in good repair Leaks around the doors and through cracks in the walls are frequent causes of spoilage The silo itself may deteriorate rapidly if the walls are not given proper care These matters should be given attention before the silo-filling season arrives

See that all silo doors are on hand and repair those not in good condition In case the doors do not fit tightly, tack or glue strips of felt, such as those commonly used in weather-stripping windows, to the edges of the doors which come in contact with the floors and with the walls

If necessary, treat the walls of the silo The action of the acid of silage destroys some of the cement of the walls or mortar joints of silos The mortar joints of tile and brick silos may shrink a little with the formation of tiny cracks which permit some air to seep through into the silage If the wall of a concrete silo has become rough, a cement-plaster coat may be necessary to prevent some of the gravel used in the concrete from becoming loose and falling into the silage A cement coating may be applied by means of a cement gun which sprays the walls with great force

A simple treatment for silos with mortar joints is to clean the walls thoroughly and then, using a paint brush, to apply melted paraffin to the joints When the weather is not too cold the treatment can be carried out while the silo is being emptied, thus avoiding the expense of rigid or swinging scaffolds Another possibility is to treat the joints at filling time Since the paraffin hardens almost immediately, it may be applied to the lower part of the silo before filling starts and to the upper parts during stops in the filling process With this plan, only a short ladder, instead of scaffolding, is required

Agricultural experiment stations and manufacturers of silos are in a position to recommend various other suitable treatments

Harvesting crop at best stage The keeping qualities of the silage, as well as its nutritive value, are to a large extent dependent upon

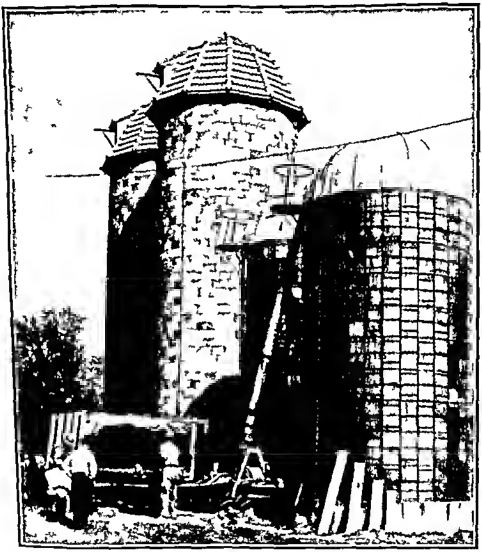

FIG 26.3 Although silos have been in use in the United States for about 70 years experiments are still being conducted to learn the value of various crops for silage and the best methods of making silage The two smaller silos in this picture are being used in a study of grass-legume silage

the stage of development of the crop at the time it is put into the silo No one rule for the best stage at which to harvest can be given for all crops Each species of forage crop has special characteristics Recommendations for the best stage for harvesting a few of the principal silage crops are given below

In general, the dry-matter content of crops is the best guide to the proper stage for harvest Crops having a dry-matter content of less than 25 per cent when they are ensiled usually lose some of their juices as seepage from the silo When there is more than 30 per cent dry matter, the forage may be too dry and the silage may become moldy As a general guide, therefore forage crops which contain from 25 to 30 per cent dry matter and are ensiled immediately in accordance with the directions given in this chapter, have good keeping quality

As corn nears maturity especially in hot, dry weather, the dry-matter content increases rapidly In cases in which the silo-filling operation is expected to last over 2 or 3 weeks, start silage harvest somewhat before the optimum stage, as determined by dry matter tests, has been reached so that the crop does not become too dry before the filling job is completed On farms where large acreages of corn or sorghum are ensiled, it is sometimes advantageous to select hybrids or varieties which mature at successive intervals so that the silage harvest may be extended over a considerable period without having the crop become too dry

For alfalfa, alsike clover, and red clover a medium-to late haying stage is best, that is, when they are well advanced in bloom These crops should not, as a rule, be ensiled when thoroughly wet with rain or dew, the leaves hold so much water that a poor-quality silage having an offensive odor is likely to result

Cereal grains should be ensiled as soon as they have reached a stiff-dough stage Earlier harvest may be best in dry, hot weather Ensile common Sudan grass before it heads, permit it to wilt, and add a conditioner such as *molasses* Harvest sweet Sudan grass after it has headed and reached full development but before it begins to dry up No conditioner is needed when ensiling sweet Sudan grass

For soybeans and cowpeas a good haying stage is best, that is, when, if the crop were cured for hay, the seed would be one half or more full size

Cut sweet clover in full bloom, wilt for 2 to 5 hours, and add molasses or other suitable conditioner

Harvest legume grass mixtures for silage as soon as the grass or legume which forms a high proportion of the mixture has reached the recommended stage If grass and legume are present in about equal amounts, be guided by the condition of both

Determine dry-matter content If there is doubt concerning the readiness of a crop for harvest, make determinations of its dry-

matter content. To do this, select a representative portion of the crop from 3 to 4 parts of the field. In the case of corn, select 8 to 10 plants representing as nearly as possible the condition of the crop. For meadow crops, harvest a few square yards with sickle or scythe from different areas. Chop fine, and mix sample thoroughly. Weigh out on a milk scale to one-tenth pound a 3- or 4-pound sample. Spread in a thin layer in baking pans lined with newspaper. Dry in the oven of the kitchen range. For the first hour, keep the temperature low enough not to char the paper (250° F) After the first hour, keep the temperature at 225° F. Continue to dry, preferably overnight, until after several weighings there is no loss in weight. To get the percentage of dry matter, multiply the dry weight by 100 and divide by the fresh weight.

Using necessary precautions in storing. Observing the procedures which have been established as essential to good silagemaking helps to insure good quality in the product

Chop finely and pack closely. Several different machines are used for harvesting corn and the sorghums. One of these is the corn harvester which cuts the corn, binds it into bundles, and elevates the bundles onto a truck or trailer wagon driven alongside. With this plan of operation, the bundles are unloaded one at a time into a "silo filler" which chops and elevates the cut crop (usually by blower) to the top of the silo. Another type of machine is the forage harvester with attachments for both row crops and meadow crops. These harvesters cut the crop, chop it, and elevate it (usually by blower) onto trailer wagon or truck in one operation. The chopped crop is transferred into the silo by means of a blower elevator. When forage harvesters and mechanical dump trucks are employed, the amount of hand labor is greatly reduced as compared with the corn-harvester silo-filler method. The latter method is adapted to small acreages of crop and usually requires less investment in equipment than does the forage harvester method.

No matter what type of equipment is used, the crop should be chopped into pieces not more than one-half to three-fourths of an inch long. This makes it possible to pack the crop closely in the silo. For efficient cutting, the knives of the machine must be sharpened frequently. Dull knives permit dry corn husks to go through uncut and this prevents close packing. Dry corn, coarsely cut, often contains air pockets which permit the development of moldy spots

It is necessary that the crop be packed solidly in the silo. A sectional distributor pipe attached to the end of the blower pipe is

the best means for spreading the chopped crop Keep this constantly in use as long as the silo filler or blower is operated, and spread the crop evenly A specially designed distributing device which is placed in the upper part of the silo and which receives the chopped forage from the blower pipe may also be used

Use special methods for trench silos Special methods are used in filling trench silos and in making stack silage Either chopped or unchopped forage may be used Thorough packing is essential A common method of packing is to use trucks for hauling the forage and to drive the truck over the forage already in the trench or stack Wagons or tractors may also be used The covering of trench silage may consist of roofing or a kraft paper held in place at the sides of the trench by earth or it may consist first of a layer of straw or other dry roughage followed by a 4- to 6 inch layer of earth well rounded to shed water

Prevent air leaks at doors A common source of trouble in filling silos is air leaks around the doors To prevent this difficulty, apply a roll of medium-weight roll roofing Thrust a broomstick through the roll, attach a rope near each end of the stick and attach the rope to the door frame of the silo As the silo is filled unroll the roofing upward against the doors leaving it in one piece from bottom to top of silo The usual length of the roofing in a roll is 36 feet, which is sufficient for an ordinary silo The pressure of the silage holds the roofing against the doors and makes a tight seal

Protect surface from spoilage Surface spoilage in silos not opened for feeding for several months can be reduced by covering the silage with roofing held in place by a suitable weight or by means of a number of other devices In using the roofing method stop the silo filler or blower elevator before the last two or three loads of forage are put in, level the surface and tramp it thoroughly Starting at the side of the silo farthest from the blower, spread strips of roofing lapping the joints 4 to 5 inches and turning up the ends against the wall to the same height Then apply the last two or three loads of forage being careful not to walk on the roofing Instead of forage other materials such as dry earth agricultural limestone sawdust or a 10 inch layer of ground corncobs thoroughly soaked with water may be used These may be sacked and stored at the top of the silo when feeding of the silage is begun

The number of rolls of roofing of usual size (3 feet in width and 36 feet in length) needed for treatment of the surface in this manner are for a silo 12 feet in diameter 1½ rolls for a 14-foot silo 2 rolls, and for a 16 foot silo 2½ to 3 rolls

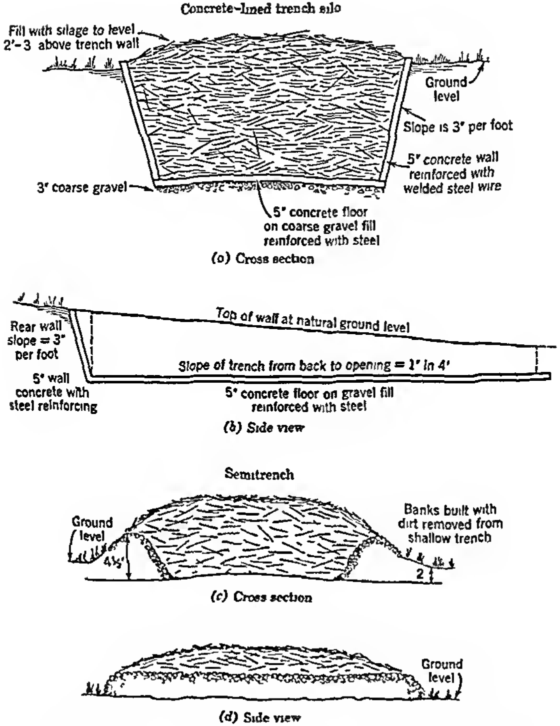

FIG 264 Trench silos provide low-cost emergency storage of silage These charts show the fundamental steps in building and filling trench silos (Ill Agr Exp Sta)

Observe precautionary measures The filling of silos involves many risks It is best to employ or work with an experienced person when filling a silo for the first time

Large amounts of carbon dioxide are produced within 12 to 24 hours after forage has been placed in the silo The gas, which is colorless and odorless, is heavier than air and may accumulate at the surface of the silage in quantities large enough to suffocate a person unless doors are open down to the level of the silage Following a delay in the silo-filling operation such as an overnight stop, start the blower to ventilate the silo before entering Occasionally, another dangerous gas, nitrogen dioxide which is yellow-brown in color, may accumulate in closed silo chutes

Grass silage a forward step The development of satisfactory methods for preserving grass and legume crops as silage is a noteworthy contribution to the advancement of soil and water conservation programs Most intertilled row crops rapidly deplete the soil of plant food and at the same time permit harmful erosion to occur when they are grown on sloping land Moreover water run-off is rapid and much of the rainfall is lost Erosion is often a serious problem in the case of silage crops such as corn because of the land being left almost bare from the time of forage harvest until a new crop becomes well established many months later

Grass and deep-rooted legume crops on the other hand, hold the soil tenaciously Since they occupy the land most of the year (often continuously for several years or until it becomes necessary to reseed them), erosion is reduced to a minimum Water run-off is slowed down on pastures and meadows giving the soil a much better opportunity to absorb water than is the case in a cultivated field The soil of pastures and meadows is absorptive because of the loosening effect of the great mass of fibrous roots and also the penetration to considerable depths of deep rooted legumes

The outstanding advantage of grass and legume silage, however, lies in the comparatively small losses to the soil in plant food, especially nitrogen, when these crops are utilized for silage Grass silage is sometimes made from surplus pasturage Legume silage, or a mixed grass legume silage, is usually made from meadow crops grown especially for the purpose, the first cutting only being ensiled In the case of both pasture and meadow crops, the growth subsequent to silage harvest is commonly pastured off In pasturing a crop, of course, much of the plant-food content of the crops is returned directly to the soil The value of legumes in helping to maintain the nitrogen and organic matter content of the soil is one of the two out

standing advantages in the use of legumes for silage The other is their value in supplying protein to the ration, thus replacing protein feeds ordinarily purchased

Using extra care in making grass silage. It is more difficult to make good-quality silage from grasses and legumes than from corn, chiefly because the grasses and legumes contain smaller amounts of fermentable carbohydrates than does corn Thus less acid is produced to aid in preservation of the silage than is the case with corn

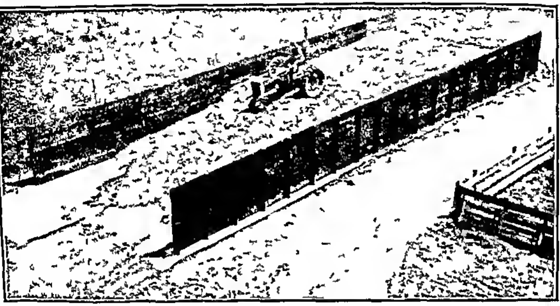

FIG 26.5 Bunker-type silos are quickly filled with a minimum of equipment, and the silage is readily self-fed Smooth rigid sides help prevent losses (Courtesy, Doane Agricultural Service)

When corn is ensiled at a very immature stage, the silage is sour, but keeps well When grasses and legumes are ensiled at too early a stage of development and care is not taken to dispose of the excess moisture, an abnormal type of bacterial action takes place and the resulting silage is likely to have an offensive odor and to be soggy and unappetizing

Employing the best possible method A number of different procedures are followed in the making of silage from grasses and legumes Use the one which best fits into your farm program[1]

[1] Several of the procedures given require an estimate of the amount of forage In the absence of wagon or truck scales an estimate of the weight of chopped forage can be made by calculating the number of cubic feet of forage in a load One ton of freshly chopped, unwilted grass occupies about 100 cubic feet of space in wagon or truck Hence, the number of cubic feet of forage divided by 100 gives the weight in tons

1 *Mix with green corn or green sorghum* This method usually insures a good quality of silage, but is limited to crops which are available and ready for cutting at the time when corn or sorghum has reached a suitable stage for harvest Forage-type soybeans mixed in the proportions of one-third to one-half soybeans by weight and the remainder consisting of corn or sorghum forage makes a good combination for silage Another possibility is third-cutting alfalfa mixed with corn or sorghum forage For best results both in keeping conditions and in feeding results, mix the crops thoroughly as they go into the silo No special treatments are needed when this procedure is followed

2 *Mix with molasses or whey* Mixing some material that contains sugar, such as molasses or dried whey, with the chopped green forage is one of the most satisfactory ways of making grass and legume silage The substances are termed conditioners or additives They promote a desirable type of fermentation with the production of lactic and acetic acids When a suitable concentration of these acids is reached, further bacterial action is inhibited as long as the silage is not exposed to air

The use of one of these two conditioners aids in assuring successful keeping qualities (1) when the moisture content is not optimum, that is, when it is a little too high or too low (2) when the forage consists of legumes only, and (3) when weeds (which are often unappetizing) are present Liquid blackstrap molasses, dried blackstrap molasses, or corn molasses may be used with about equally good results The amounts of any of these forms of molasses or of dried whey which are needed per ton of chopped forage are:

	lb
For grasses	40
For grass-legume mixtures	60
For alfalfa or the clovers	80
For soybeans	100

Somewhat larger quantities do no harm and in some cases may be useful About three-fourths of the molasses or whey remains in the silage and adds to the feeding value

The liquid molasses may be pumped or allowed to run by gravity from an elevated drum onto the forage on the apron of the elevating machine Place the drum on a small platform scale, and adjust the amount used according to the weight of the forage ensiled

3 *Mix with cereal grains* Corn (either corn ears or shelled corn) oats barley, and wheat, when ground and mixed with the chopped

forage at the rate of 200 to 250 pounds of grain per ton of forage, usually improve the keeping qualities and feeding value of grass and legume forage which is ensiled when it contains a high moisture content. The ground grain absorbs some of the excess moisture and promotes a better type of fermentation than when nothing is added.

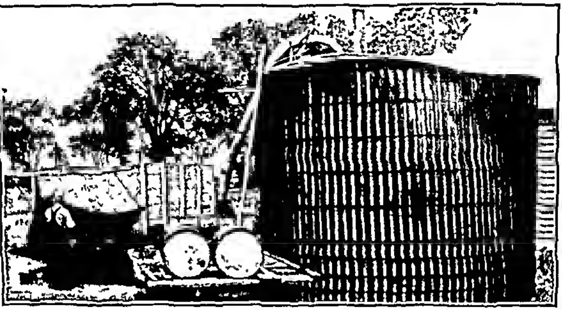

FIG 266 Temporary structures such as this slat crib may be satisfactorily used for emergency storage of silage The drums store liquid molasses which is being added by the blower-elevator to the forage.

The use of the ground grain in forage which is on the dry side, however, may be harmful, since the drying effect of the grain may be sufficient to prevent fermentation from proceeding in the normal manner. The silage may mold if too dry.

The ground grain may be added by (1) sprinkling on the forage in the conveyor of the blower, (2) by spreading on top of the forage in the truck or wagon before unloading, or (3) by elevating sacks of the grain into the silo and sprinkling over the surface.

The use of ground grains in making grass and legume silage is usually an expensive procedure from several standpoints: (1) the cost or market value of the grain is high; (2) a considerable amount of labor is required in adding the grain to the forage; and (3) the use of grain defeats the purpose of the grassland farming program. For example, if corn were the grain used, 20 to 25 bushels would be needed for each acre of first-cutting alfalfa yielding 6 to 7 tons to the acre. Thus one-fourth to one-half acre of corn (depending upon yield) would be grown for each acre of alfalfa ensiled.

4 *Mix forage with acid* Forage to which phosphoric acid is added at the time of ensiling keeps well but dairy cattle eat it with less relish than silage treated with molasses or ground grain The amounts of phosphoric acid prepared especially for silagemaking (68% commercial grade) recommended per ton of green forage are for grasses 10 pounds for alfalfa and the clovers 15 pounds and for soybeans 20 pounds The acid should be poured *into water* in a tank or drum the volume of the water being five times that of the acid *Never pour water into acid* The mixture may be allowed to flow by gravity into the blower or to drip onto the forage in the conveyor of the blower elevator

5 *Treat with sulphur dioxide gas* Several experiment stations have reported successful results in the use of sulphur dioxide gas as a treatment for grass and legume silage

The use of sulphur dioxide gas is fraught with considerable risk since the gas if breathed by the operator or others may cause great harm This procedure has been largely supplanted by the method described below

6 *Use sodium bisulphite* The use of this dry chemical compound which releases sulphur dioxide gas after it is mixed with freshly ensiled moist forage has been found satisfactory in tests at some experiment stations The method of application is more convenient and the dangers from its use are less than when the sulphur dioxide gas method mentioned in the foregoing section is used Eight pounds of the sodium bisulphite powder per ton of fresh forage is the recommended amount The powder is usually applied by means of a metering device or by hand to the forage as it enters the blower elevator

Precautions in the use of the sodium bisulphite method include (1) do not use wilted grass (2) regulate rate of application carefully (3) do not work in the silo while the blower elevator is working (4) do not use this method for trench silos that are poorly drained and (5) do not use larger than the specified amounts Excessive quantities may cause bleaching of the silage and also lower its palatability

7 *Wilt the forage* Grasses reach a suitable dry matter stage for harvest as silage earlier in the season than do the legumes Many of the legumes are high in water during the early stages of growth and if in pure stand are not satisfactory for silage unless their condition is corrected by permitting them to reach an advanced haying stage or by other means Ladino clover for example in pure stand

remains too high in moisture to be ensiled directly from the standing crop. Sweet clover and alfalfa at immature stages are also high in water content.

Three procedures are possible when high-moisture forage is to be ensiled, namely, (1) mixing with ground cereal grains to absorb

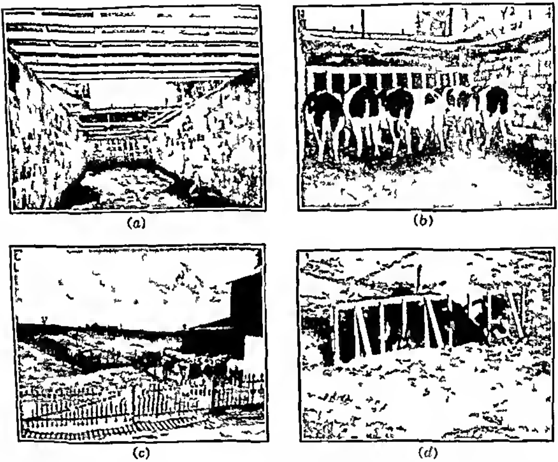

FIG. 267. (a) Trench silo with concrete block side walls and concrete floor. Roof over part of trench. (b) Self-feeding silage in trench silo. (c) An emergency trench silo with self-feeding device. (d) Cows eating silage from trench silo. (Photographs a and b courtesy The Kraftsman; photographs c and d courtesy The Sealtest Dairyman.)

excess moisture as heretofore described, (2) mixing with ground hay or other dry forage in the same way as described for the grains, and (3) wilting the forage before ensiling.

Wilting the forage in the swath for 1 to 3 hours on a dry, sunny day is usually sufficient to bring the dry-matter content up to the required level. On damp, cloudy days drying occurs slowly. When the dry-matter content is at the proper level, good keeping conditions in the silo are frequently obtained by ensiling the forage with-

out any other treatment One of the great drawbacks to the wilting method however, is the difficulty of obtaining the right degree of moisture loss

Some methods ineffective Several other ways of treating grass and legume forage have been tried In carefully conducted tests at experiment stations, *lactic acid cultures commercial bacterial cultures* salt urea and sodium nitrate were in most cases shown to have no beneficial action Experiments are still under way however and it is possible that methods may be further improved and still untried compounds may prove useful as silage additives In European tests, formic acid has been effective for this purpose

Estimating money value of silage There are no prevailing market prices for silage since this feed cannot be readily transported It is sometimes necessary, however in keeping farm accounts or in settling affairs between landlord and tenant to estimate the money value of silage

Corn silage In studies conducted at the Illinois Experiment Station the ear and leaf stalk portions of corn forage at the silage harvest stage were separated dried and weighed The corn comprised a number of hybrids which produce good yields of grain when grown in central Illinois A close correlation was found between the stage of development (as shown by the dry-matter content of the forage) and the ear content (Table 26.2) The number of bushels of ears in a ton of forage increased rapidly from early to late harvest stages but there was little change in the number of pounds of the leaf-stalk fraction

Table 26.2 Ear and Leaf-Stalk Content in 1 Ton of Corn Forage at Various Stages of Development *

Dry Matter of Forage %	Ears bu †	Leaves and Stalks lb ‡	Dry Matter of Forage %	Ears bu †	Leaves and Stalks lb ‡
15	0 2	308	24	3 1	312
17	0 8	309	26	3 8	313
19	1 5	310	28	4 4	314
21	2 1	311	30	5 1	315
23	2 8	312	32	5 7	315

* Nevens W B et al Ill Agr Exp Sta Bul 576
† 15% moisture basis 70 lb of ears per bu
‡ Hay-equivalent value 15% moisture basis

An estimate of the dollar value of corn forage at the silage stage or of corn silage may be made as follows

1. Determine the dry-matter content of the forage or silage by drying a weighed sample amounting to 3 to 4 pounds in the oven of a kitchen range at a temperature of 225–250° F. overnight or until it loses no more weight. To get the percentage of dry matter, multiply the dry weight by 100 and divide by the fresh weight.

2. Using this figure and Table 26.2 as guides, list the number of bushels of ears and the pounds of leaf-stalk hay-equivalent in a ton of forage or silage. Corn leaves and stalks are estimated to have about 90 per cent as much feed value as good-quality grass hay. This factor has been used in converting the weight of leaves and stalks into the "hay-equivalent" values shown in the table.

3. Apply market prices for ear corn and grass hay to the bushels of ears and leaf-stalk portions, respectively. The sum of the two gives the dollar value per ton.

Other silage. Silage made from other crops than corn may be estimated as worth 25 to 30 per cent as much as a ton of the same crop when well cured and in equally good condition, for it takes 3½ to 4 tons of green crop as it stands in the field to make one ton of well-cured hay or other forage.

Estimating capacity of silo. Because of wide differences from year to year in the moisture content of the crop ensiled, it is impos-

Table 26.3. Capacities of Silos: Approximate *

These figures are for settled silage. Note that, as depth increases, capacity increases *more than* proportionally, owing to the fact that the greater weight packs the silage more tightly.

Depth of Silage, ft.	Amount of Silage at Given Silo Diameter, tons †					
	10 ft.	12 ft.	14 ft.	16 ft.	18 ft.	20 ft.
20	35	50	68	89	113	139
24	43	62	85	111	140	173
28	52	74	101	132	167	207
32	60	87	118	154	195	241
36	...	...	135	176	223	275
40	...	...	152	198	251	310
44	...	...	...	220	279	344
48	...	...	...	...	307	379

* Cir. 603, U.S.D.A.

† Based on well-cared corn silage cut in ½-inch lengths or less, harvested before kernels are fully dented and hard, with about 70 to 74% moisture. Quantities will be less for longer cut, fewer ears, or corn farther advanced in development.

sible to state exactly the capacity of a silo in terms of tons For example, a silo holds many more tons of corn harvested at an immature stage (when it is high in water content) than it does of fully mature corn The same principle applies to other crops Further, a crop that has been wilted before it is put into the silo weighs less per cubic foot than the same crop ensiled directly after mowing

With the above points in mind, an estimate of the approximate capacity for any kind of silage can be made from Table 26 3

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REVIEW

1 What crops are most used for silage? What changes are taking place in the kinds of crops used for silage?

2 What factors influence the choice of a crop for silage? Discuss each of these

3 Explain the procedures which should be followed in preparing a silo to receive a silage crop

4 How is the proper stage for harvesting silage crops best determined? List the best stages at which to harvest the principal silage crops

5 List the necessary precautions which should be taken when ensiling forage and explain each in detail

6 What are the advantages of grass silage and what grass and legume crops may be satisfactorily used for silage?

7 List seven procedures which may be used in making grass silage Discuss the advantages and disadvantages of each

8 How may the money value of silage be estimated?

27

Planning and Equipping the Dairy Barn

Labor is the second largest item entering into the cost of milk production. Since much of the labor in feeding, caring for, and milking cows is done in the barn, the convenience of the barn arrangements greatly affects the amount of labor expended per cow. If the barn is to be used for the production of milk for the retail trade, it is essential that provision be made to meet the sanitary requirements of local and state boards of health. Convenient, light, well-ventilated barns also aid in making the task of caring for cows a pleasant one and are a distinct asset in the securing and keeping of competent helpers.

As a man seldom builds a dairy barn for his own use more than once during his lifetime, it is wise, in making plans, to take advantage of those principles which have been generally adopted by successful dairy farmers. For plans showing standard barn arrangements, as well as recent developments in the construction of economical buildings and the use of many new materials and devices, consult your state agricultural experiment station, the Bureau of Dairying of the U. S. Department of Agriculture, or barn-equipment companies that have barn-plan service departments. For specifications covering sanitary requirements in barns and milk houses, consult your local or state board of health.

Considering the functions of the barn. Intelligent planning of the barn is best done in light of the functions which the barn is expected to fulfill. Among these functions are:

1. Protection of the herd and workers from inclement weather.
2. Arrangements which will permit the work to be done with a minimum amount of labor.
3. Provision of suitable surroundings for the production of high-quality milk.
4. Location convenient to other farm buildings and to highway.
5. Investment such that annual cost can be readily met by returns from the herd.

6 Attractive buildings which will add to the value of the farm property and to the pleasure of farm life

Protecting the herd and workers In the northern part of the United States dairy cattle must be protected from inclement weather for 5 to 7 months of the year Year-round protection from storms must be provided for the cows at the milking hour In the southern sections of the country, less protection from cold is needed and in the extreme southern and southwestern areas protection from extreme heat may be fully as important a consideration as protection from cold and storms

Some experiments have shown that properly fed dairy cows produce well at temperatures below those at which men can comfortably work with bare hands In cases where the milking room is separate from the stable artificial heat may be needed to keep workers comfortable and to prevent water pipes from freezing Frequently one heating system may be utilized for these purposes and also to provide hot wash water for the milk utensils

Winter protection In order that suitable recommendations for the construction insulation and ventilation of dairy barns may be made for all sections of the country the U S Department of Agriculture has compiled weather information and prepared a chart which shows the entire land area divided into four separate zones Average January temperatures relative humidity, and hours of sunshine comprise the data from which the zones were charted and on which the recommendations are based

In zones 1 and 2, buildings must be constructed warmly enough (1) to protect water pipes from freezing (2) to prevent the accumulation of excessive amounts of frost on windows and other portions of the interior, (3) to provide comfortable temperatures for young calves and (4) to keep the workers comfortable The buildings must also be strong enough to withstand the weight of heavy snows Two principal construction features namely, insulation and ventilation, aid in providing winter comfort

Insulation Many new research findings and the manufacture of new insulating materials now make possible the effective insulation of farm buildings Thick masonry walls are no insurance against heat loss A stone wall 24 inches thick is rated as giving no more protection from heat loss than a wall built of wood studding covered with ¾-inch drop siding and paper on the outside and 1 inch wood sheathing on the inside In barns with frame walls heat loss

may be reduced by filling wall spaces with a suitable insulating material.

For most effective results, barn walls and also ceilings must be kept dry. Dampness in walls is destructive to mortar joints and timbers and also reduces the usefulness of insulating materials. A vapor barrier, such as sealed metal sheets, aluminum pigment paint, and

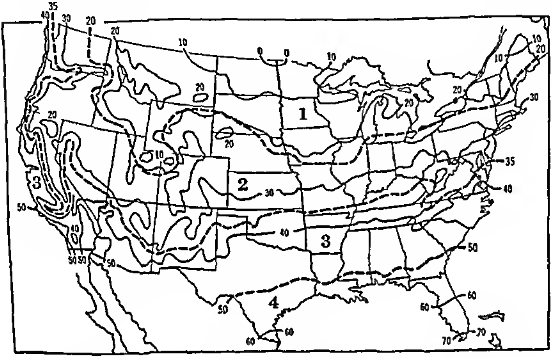


FIG 27 1 The design of dairy barns is greatly influenced by climatic conditions The zones (separated by dotted lines) are based upon temperatures, hours of sunshine, and relative humidity during January The solid lines show mean January temperatures (Bul. 470, Wis Agr Exp Sta.)

asphalt-coated paper roofing, may be applied next to the inside finish layer of walls and ceilings. The exterior of walls should not be protected by a vapor barrier, since "breathing" of the wall, that is, escape to the outside of moisture which has accumulated in the wall, is necessary.

In addition to the use of insulating materials in the construction of walls and ceilings, several other devices may be employed in order to conserve heat. It is recommended that stanchion barns in zone 1 be provided with storm sash and storm doors, and that the doors be insulated. Storm windows and insulated doors are also desirable in zone 2. Windows consisting of glass blocks or two large panes of glass which are sealed to prevent condensation of moisture between

the panes may be substituted for windows and storm sash In the installation of these two types of window, the directions of the manufacturer must be followed, to allow for proper expansion to prevent breakage and to prevent such concentration of the rays of the sun on a focal point as to be a possible fire hazard As a rule, none of these insulating materials are needed in zones 3 and 4

In the pen barn plan of housing insulation is not often used for the loose housing area but is usually desirable in the construction of the milking room (milking parlor) and milk house In Wisconsin experiments, an insulated loose housing barn proved unsatisfactory because of excess condensation of moisture even though artificial ventilation was used

Ventilation A controlled means of exchanging the air in dairy buildings is essential to

1 Prevent condensation of excess moisture on windows, walls, and ceilings

2 Assist in maintaining desirable temperatures

3 Provide fresh air without drafts directly on the cattle

4 Prevent absorption of objectionable odors by milk

Excessive moisture in the barn is objectionable because (1) frost collects on windows, doors walls and ceilings, causing the interior to become excessively damp and the floors slippery, (2) humidity depresses the appetites of cows (3) timbers and woodwork rot, and (4) mortar joints and glued timbers loosen Constant change of air is needed chiefly because of the need for removing high moisture air and replacing it with outside air of lower moisture content A milking cow gives off in the exhaled air as much as 0 5 to 0 75 pound of water vapor per hour, or 12 to 18 pounds daily Only under exceptional conditions does carbon dioxide accumulate in the air in sufficient concentrations to cause harm, for in most barns there is some leakage of air around doors and windows

Unless use is made of a system of ventilation which is properly designed so that it automatically regulates the temperature, there is likelihood that the stable will become either too warm to permit the cows to produce at their best or so cold that water pipes may freeze Cold drafts striking directly on cows may predispose them to arthritis or mastitis Further, extreme changes such as may occur between midday and early morning are undesirable Suitable temperatures for cow stables in winter are as follows zone 1, 35 to 45° F, zone 2 40 to 50° F zone 3, 45 to 55° F As a rule these temperatures provide comfort for both cows and workers provided other

requisites, such as adequate ventilation and ample bedding, are met.

Most of the recommendations concerning ventilation which are given above apply to stanchion barns. The loose-housing portion of pen barns is usually ventilated by leaving an outside door open, thus making the installation of a ventilation system unnecessary. Further, the recommendations apply almost entirely to zones 1, 2, and 3. In zone 4, the chief ventilation problem is keeping the cows cool in summer. This is sometimes accomplished by means of large fans above the cows, or by stabling the cows in open-sided shelters. Summer ventilation is also employed to some extent in the northern states, this being done by fans or by exhausting air from the stable through the mow hay-drying system.

Regardless of the type of barn used, it is necessary that both the place where the milking is done and the place where the milk is cooled and stored be well ventilated to prevent absorption of odors by the milk. The most common odor of milk, the "cowy" odor, is caused by the absorption of odors from the barn air.

Gravity ventilation. Since warm air is lighter in weight than cold air, exchange of air and fairly good control of temperatures within the stable can be obtained through properly designed gravity ventilation systems. Outtake flues opening near the floor of the stable carry the outgoing air above the ridge of the barn. Winds accelerate the movement of air through such flues. Intake flues are installed in the wall and extend upward, opening in or near the ceiling. Direct openings to the outside are avoided to prevent drafts. In settling to the floor, the cold air is mixed with the warm air, thus reducing the danger of chilling the cattle Flue systems of ventilation are usually provided with some manual controls which can be operated to prevent temperatures from falling below the freezing point on cold nights. These systems are usually supplemented by window sashes which are hinged at the bottom so that they can be opened inward at the top. Metal shields at the sides prevent side drafts.

Mechanical ventilation. For barns which are supplied with electric current, ventilation systems primarily dependent for their successful operation upon thermostatically controlled electric fans may be installed. These systems are usually designed to provide, with the combined capacity of all flues in the barn, about 150 cubic feet of air per minute per cow. Some means of manual control should also be provided for emergencies, such as failure of electric current, or accident to fan or motor.

Heat exchangers In cold climates the unrestricted escape of warm air through the flues of a gravity ventilation system may reduce the temperature of the stable to too low a point when the outside temperature drops sharply On the other hand the problem of unusually low outside temperatures is not completely solved by a thermostatically controlled system for an insufficient supply of fresh air may result from shutting off the exhaust fans as the temperature drops Experiments have been conducted with heat exchangers that is devices for tempering the incoming cold air with the heat from the outgoing warm air

In experiments conducted at Iowa State College[1] fresh air was brought into the stable through a series of small, round flues These were built within larger flues which carried the warm outgoing air from the stable Various modifications of this plan were also tried The exchanger warmed the fresh air from the heat of the exhaust air and thus made possible a sufficient supply of fresh air and the maintenance of a comfortable temperature It was found that from 41 to 48 per cent of the heat loss in the outgoing air could be prevented

Another plan sometimes used is to exhaust the air from the stable into the hay mow where the heat from the stable air partially warms the mow air The mow air as brought into the stable may be 20 degrees warmer than outside air This plan must be used with caution because the exhaust air carries a large amount of water vapor which may be condensed on the timbers and inside of the roof, thus inducing loosening of glued timber joints and rotting of wood work

To assure successful operation of any ventilation system the system must be designed by someone who is trained or experienced in this field of work State agricultural colleges and barn equipment companies are in a position to offer helpful suggestions

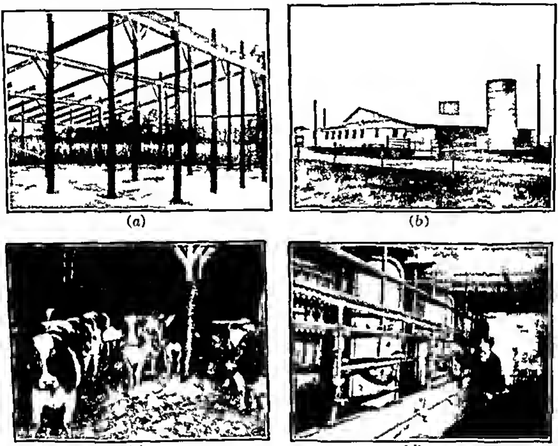
Summer protection Even in the northern states dairy cows need protection from the extreme heat of summer Simple shelters may consist of trees or open sided sheds built of poles with roofs of sheet metal waterproof paper or straw Another expedient is to keep the cows in a fan ventilated barn during the hottest hours of the day and turn them to pasture in the evening

In the southern and southwestern states dairy barn construction may be of the simplest form with particular attention given to sum

[1] Giese H and Downing C G Application of Heat Exchangers to Dairy Barn Ventilation Agr Eng *31* 167 1950

ner comfort In a few areas, such as southern California, cows are kept in corrals and brought into special milking rooms for milking

Planning labor-saving arrangements Before making plans for building or remodeling your barn, study the different styles of barns



(a) (b) (c) (d)

FIG 27 2 High building and labor costs have led to increasing use of pen barns and separate milking parlors (a) Framework in process of construction (b) Completed pole barn and milking parlor (c) Interior of barn (d) Interior of milking parlor (Photograph a courtesy The Kraftsman photographs b c and d courtesy The Sealtest Dairyman)

in use and the advantages they offer in the saving of labor Visit some barns on the best dairy farms in the community or in other dairy regions Ask your county agent or state agricultural college for publications or other information concerning recent developments in barn construction

Pen barns In recent years many dairy barns of the pen or loose-housing type have been built in preference to the conventional stanchion-type barn Some stanchion type barns have been converted to the pen type arrangement

Advocates of pen-type barn claim the following advantages for this system in comparison with the conventional stanchion barn (1) makes it possible for one worker to care for and milk more cows, (2) initial investment is comparatively low since the loose-housing portion may be a simple and economical type of construction and the milking room is a small part of the structure or a small separate building (3) provides for expansion of the herd easily and with little extra cost, (4) in a large herd, cows can be milked easier and faster in a special milking room, (5) manure conservation and handling are more efficient because the manure pack in the bedded area retains more of the fertility of the excreta, (6) the manure can be removed by a power scoop at times when it is best applied to the soil, (7) there are fewer injuries to animals, particularly to udders and legs, (8) cows in heat are more easily detected, and (9) the loose-housing portion may easily be converted for use by other livestock

After a carefully conducted 10-year experiment at the Wisconsin Experiment Station in which loose-housing barns were compared with a stanchion barn,[1] it was concluded that (1) herds produced equally well in a warm stanchion barn and cold loose-housing barns, (2) there was no observed relation between temperature of the barn and production, (3) nutrient requirements per pound of milk (FCM) were essentially the same for all barns, (4) high-quality milk was produced consistently under all systems, (5) loose-housing barns required 60 per cent more bedding, (6) there was little difference in health of cows except that injuries common in the stanchion barn (stepped on teats, swollen hocks, stiffness, and lameness) were almost absent in the loose-housing barn, and (7) special care was needed for calves born in the loose housing barns in cold weather

Experiments at the North Dakota Station,[2] in which the effects of type of shelter and temperature upon production were studied, revealed that cows which are fed an adequate ration, have shelter from wind, snow, and rain, and have a dry place in which to lie down, produce as well as cows in a barn where the temperature is about 50° On the other hand, similar experiments with yearling heifers showed that heifers kept in warm barns grew more rapidly and consumed less feed per pound of gain than heifers housed in open sheds

[1] Heizer E E et al A Summary of Studies Comparing Stanchion and Loose-Housing Barns J Dairy Sci *36* 281–292 1953

[2] Dice J R Some Effects of Type of Shelter upon Dairy Cattle N Dak Agr Exp Sta Bul 344 1940

In experiments carried out by the Bureau of Dairy Industry at Huntley, Montana,[1] cows kept in pen barns produced more milk and gained more weight than cows housed in stanchion barns It was

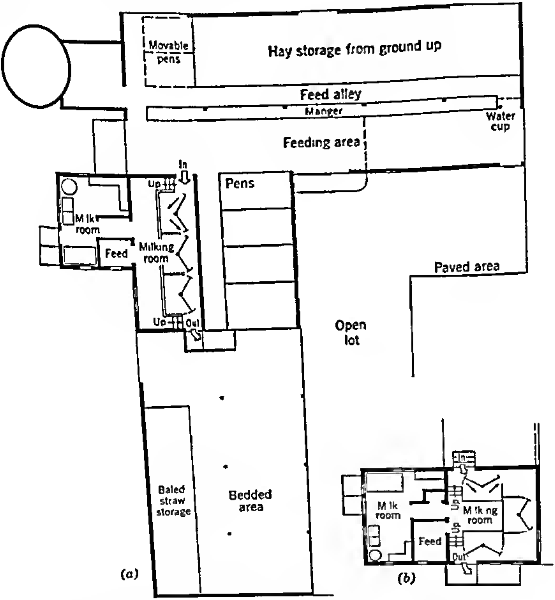


FIG 27.3 Floor plans of a loose-housing arrangement, showing in-line milking stalls together with cow and calf pens The inset shows a similar arrangement, except that the milking room is of the U-type (Cir 694 Ill Agr Exp Sta)

concluded that in cold climates there is probably little difference between lounging barns and stall barns in total cost of building and labor In the Wisconsin trials, it was found that a deep manure pack

[1] Graves R R., and Dawson J R Relative Milk Production of Cows in Pen Barns and Stanchion Barns Guern Breeders' J 74 612–3 1918

aided in keeping the cows comfortable The temperature of the pack remained between 80° F and 90° F all winter

Before building a loose housing barn or remodeling a stanchion barn to this form of housing it is best to ascertain the requirements of the milk market A number of large cities have been reluctant to permit the sale of milk produced in loose housing barns

Stanchion barns On the other hand those who favor the stanchion type barn find this type of housing superior to pen barns because (1) feed and bedding are under one roof a special advantage during times of deep snow or storms (2) slightly less feed is required when the herd is comfortably housed (3) only one-half to three fourths as much bedding is required (4) cows are in place ready to be milked and less total time is required for the milking operation of a small to medium sized herd than when cows must be brought in and taken out of a milking room (5) cows are likely to be cleaner (6) the cows provide heat which keeps the stable comfortable (7) calves are kept comfortable (8) less building space area is needed and (9) hay and bedding stored on the mow floor above the stable provide excellent insulation

The form of housing employed however does not insure success of the enterprise There are wide differences in the efficiency of operators Constant study of management procedures is needed in order to keep labor costs low

Planning the work program Even in barns already in use worth while savings in time and travel expended per day per cow may be effected by rearrangement of facilities by revision of routines in doing chores and through installation of new pieces of equipment In time and travel studies on five Pennsylvania farms[1] it was found under the original plan of doing chores the labor per day per cow ranged from 16 to 38 minutes When suggested changes were fol lowed savings in time ranged from 3 to 11 minutes per day per cow Before making the changes total travel distance in doing chores ranged from 662 to 2133 feet per day per cow Under the revised plan savings in travel distance per day per cow ranged from 282 to 1146 feet On one farm the travel distance per day per cow was lessened by more than one fifth of a mile For a 20 cow herd the saving in travel distance per day would amount to 4 miles

Study feeding devices A wide variety of pieces of equipment and ways of getting feed to dairy cows are in use The amount of storage pace required for feed and bedding is shown in Table 27 1

[1] Science for the Farmer Pa Agr Exp Sta Supp to Bul 529 1951

1. Grain mixtures are commonly moved from feed rooms to individual stalls or milking room by feed carts. Overhead bulk storage bins which are filled by conveyors simplify such an arrangement.

2 Hay may be self-fed from ground level storage (commonly employed in loose-housing or pen barns) or from individual, silo-like storage units These arrangements usually require the use of chopped hay.

3. Silage may be removed from a silo by an unloader which operates from the top, or upper surface of the silage in the silo, or in the case of silos especially designed for the purpose, from the bottom of the silo. In pen barn housing arrangements, silage is commonly hauled in trailer wagons and emptied into either indoor or outdoor bunks, or may be self-fed from stack, trench silos, or bunker silos.

4. Self-feeding mixtures of concentrates and ground hay may be practicable in some cases. In experiments at the University of Illinois,[1] dairy cows of moderate to high production were successfully fed in this manner. To compensate for the lower amounts of con-

Table 27.1. Storage Space Required for Feed and Bedding *

Kind and Form of Material Stored	Pounds per Cu. Ft.	Space Occupied per Ton, cu. ft.
Hay:		
Loose in shallow mows	4	512
Loose in deep mows	4.5	444
Baled loosely	15	133
Baled tightly	20	100
Chopped, long cut	8	250
Chopped, short cut	12	167
Straw:		
Loose	4	512
Baled	12	167
Shavings, baled	20	100
Silage:		
In shallow silos up to 30 ft. high	40	50
In high silos over 30 ft. high	50	40
Concentrates:		
Mixed feed	45	45
Small grain	⅘ of bu. wt.	...

* Wis Agr. Exp. Sta. Bul. 470.

[1] Harshbarger, K. E Self-Feeding a Ground Hay and Grain Ration J. Dairy Sci., 35:501, 1952

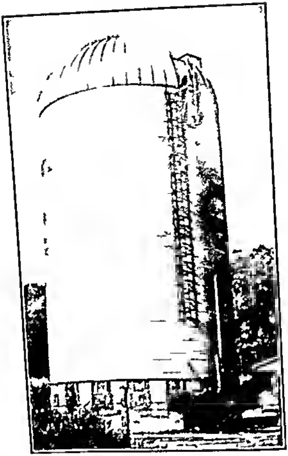


Fig 27 4 Metal hay storage units with forced draft ventilation from a central duct provide a simple means for finish curing and self feeding of chopped hay

centrates needed as production declined the proportion of concentrates in the mixture was reduced from time to time The self-feeding plan was also successfully used at the University of Nebraska in the rearing of dairy calves[1]

5 Individual feeding of grain mixtures to cows in pen barns may be accomplished by use of special feeding troughs or boxes attached to stalls in the milking room In such cases care must be exercised to allow each cow time to consume her feed Experiments have shown that cows require from 1 5 to 2 4 minutes to consume a pound of grain mixture (Table 27 2) A cow given 5 pounds of grain mixture at a feeding should be allowed at least 10 minutes to eat it

[1] Nevens W B The Self Feeder for Dairy Calves J Dairy Sci *2* 415-429 1919

Table 27.2. Cows Need Ample Time to Consume Their Feed *

Breed of Cattle	Time in Minutes per Pound of Feed Consumed		
	Grain Mixture †	Hay †	*Silage* †
Holstein	1.91	6.03	2.21
Brown Swiss	1.51	8.84	2 00
Ayrshire	...	9.49	2.75
Guernsey	1.91	12.30	3.38
Jersey	2.39	13.54	3.88

* Ann. Rept. for Year Ended June 30, 1948. Ill. Agr. Exp. Sta.
† Grain mixture was fed at milking time, hay and silage after milking. Grain mixture and silage were fed in usual amounts, *but hay was limited to 5 lb. per feeding.*

Manure removal. In stanchion barns, mechanically operated cleaners, or conveyors, may be installed for removing the manure from the gutters and conveying it into manure spreaders located outside the barn. In pen barns, the manure pack is usually removed a few times during the year by a tractor-operated scoop and loaded onto manure spreaders. Tractor scoops are also used for the cleaning of exercise lots and feeding floors.

Water supply. Water systems with individual drinking bowls are commonly used in stanchion barns. A water tank for the use of the entire group of cows is the arrangement generally used in pen barns. Freezing of water pipes in barn or milk house is prevented by the use of electric heating coils surrounding the pipes.

Producing high-quality milk. A primary function of the dairy barn is to provide facilities for the production of milk which will command a top price on the general market. Failure to comply with the board of health or purchaser's requirements may result in the milk being sold at a lower price or excluded from the market until necessary changes in barn arrangements or operational procedures have been made and compliance established. Some of the features which require special consideration in connection with high-quality milk production are discussed briefly below. A further discussion of high-quality milk is found in Chapter 22.

Durable floors and mangers. All floors in stanchion barns, milking rooms or parlors, and milk houses must be constructed of impervious material so that they may be readily cleaned. Concrete is best for this purpose. Concrete or concrete and steel are commonly

used for construction of mangers in stanchion barns For milking parlors, steel feed boxes are usually attached to cow stalls Dirt floors are approved for loafing sheds, although a paved feeding area is usually recommended

Adequate light Regular cleaning of cows mangers, gutters, and alleys is an aid to the production of clean milk An adequate amount of light helps to ensure a good cleaning job

In northern sections of the country 3 to 3½ square feet and in other areas 3½ to 4 square feet of glass per stanchion are the usual recommendations When glass blocks are used the glass area should be increased about 50 per cent To obtain maximum light and to prevent breakage windows should be placed not less than 4 feet above the floor in stall barns and 5 feet in pen barns

Lighting specifications for electric lighting call for 100 watt lamps placed 16 feet apart over each gutter and 25 to 30 feet apart in each feed alloy White ceilings and upper walls increase the efficiency of the lighting system since light is reflected to a greater extent from white than from dark surfaces

Ventilation Good air circulation promotes sanitation since it aids in the drying of the interiors of stables milking rooms, and milk houses It also helps to prevent the absorption of odors by milk

Paved exercise lots Clean cows are one of the first essentials in high quality milk production Cows wading in muddy exercise lots invariably soil their udders and bring mud into the milking room The job of cleaning cows prior to milking and of keeping them clean is greatly lessened when the exercise lots are paved Concrete paving is usually most satisfactory because the manure which accumulates may be quickly removed by power scoops or other means

Proper manure removal Manure must be removed frequently and regularly from stables or rooms where cows are milked It is desirable that the manure be spread directly on the fields but when this is not possible it should be piled at a proper distance from the barn This distance is usually specified by milk inspectors In no case should manure be piled close to the barn or against barn walls The chief objections to proximity of manure piles is that they afford good breeding places for flies and also produce odors which may taint the milk

Separate milk house Since milk readily absorbs barn odors practically all specifications for grade A or other high-quality milk production call for a milk house which is separated from the place where cows are milked Separation may consist of a short passage with

swinging doors at each end. The milk must be removed to the milk house for cooling immediately after the milking of each cow.

Locating the dairy barn. The chief considerations in choosing the location for the barn should be (1) nearness to farm dwelling and other farm buildings to reduce travel to as low a point as possible consistent with sanitary provisions and fire safety, (2) nearness to feed and bedding supplies, (3) convenience to highway over which milk is hauled, and (4) good drainage.

Cows may be cared for with a minimum of labor when feed and bedding are stored within or adjoining the dairy barn unit. Daily hauling of feed and bedding from other buildings or storage facilities usually requires much time. Mow storage, ground-level storage, and self-feeding units save much manual labor. With long stanchion barns, locate silos midway of the rows of cow stalls at one side of the barn and the milk house at the opposite side of the barn. Separate both silos and milk house from the barn by a passageway 4 to 10 feet in length. In such barns, hay and bedding are commonly stored in the loft. In pen barns, bedding and chopped hay usually are stored at ground level in the rear part of the barn. The hay storage portion may be provided with a forced ventilation mow-drying system. Often the hay is self-fed.

Providing a paved road leading to the highway is a necessity where milk is hauled daily by truck, or where feed and other supplies are delivered to the barn by truck. Hence, access to a highway is an important consideration in locating the barn.

Good drainage away from barn and lots aids in (1) protecting the barn foundations, (2) keeping floors dry, (3) keeping exercise lots dry and clean, (4) keeping cows clean, and (5) providing easy access to the barn by foot or vehicle.

Keeping investment low. How expensive a barn can your cows pay for? This is an important problem which should be given thorough consideration before building or remodeling a barn and before undertaking a dairy enterprise. The cows are the only income-producing units in the herd and therefore must carry the expense of barns for young stock and the herd bull.

It has been estimated that dairy building costs, including charges for interest, depreciation, repair, and maintenance, are about 10 per cent of total dairy costs.[1] On some farms the costs are much less

[1] Van Arsdall, R. N. *What Are the Costs of Dairy Housing?* Ill. Farm Econ., No. 190–191, 1141–1150, 1951.

than this, while on others they may exceed 20 per cent of the total dairy costs On a dairy animal unit basis, annual building costs in two dairy areas in 1947 ranged from $8 to $62, with an average cost of $24 Since the dairy animal units included dry cows, young stock, and other dairy animals, the annual building cost for each producing cow was $34 The replacement cost per dairy animal unit of the buildings and equipment, based on 1947 prices, was $286 in one area and $352 in the other area This is equivalent to $500 and $555 for each producing cow in the respective areas On one-third of the farms in the two areas, the cost of replacing the existing dairy buildings would have been about $750 per cow Detailed figures are shown in Table 27.3

Table 27 3 ***Costs of Operating Dairy Enterprises in the Chicago and St Louis Areas, 1947 Price Levels*** *

Item	Chicago Area, 162 Farms: Per Farm	Chicago Area, 162 Farms: Per Dairy Animal Unit †	Chicago Area, 162 Farms: Per Cow	St Louis Area 147 Farms: Per Farm	St Louis Area 147 Farms: Per Dairy Animal Unit †	St Louis Area 147 Farms: Per Cow
Buildings ‡	$ 727	$ 23	$ 33	$ 558	$ 24	$ 36
Equipment	165	5	7	137	6	9
Stock	413	13	19	207	9	13
Feed	6123	194	277	4155	179	267
Labor §	1097	35	50	921	40	60
Total	$8525	$270	$386	$5978	$258	$385

* Van Arsdall R N What Are the Costs of Dairy Housing? Ill Farm Econ, No 190-191 1140-1150, 1951

† Includes all dairy stock in the herd including cows, heifers, and bulls One dairy animal unit is the equivalent of one mature cow

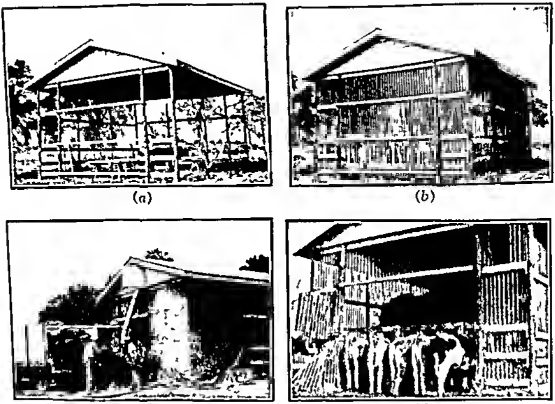
‡ Figured as 6½% of the investment.

§ Rates of $150 per mo in the Chicago area and $120 per mo in the St Louis area were charged for operator and family labor Actual costs of hired labor were used in both areas

Since building cost includes depreciation, interest, repair, and maintenance, the total annual charges average 6½ to 8 per cent of the original investment If the life of the buildings is 40 years and the original investment $500 per cow, the annual charge for buildings will amount to $32 to $40 per cow Some farms have annual costs three times as large as this With careful planning and construction, the annual cost of buildings per cow can be kept much lower, in some cases as little as $25 per cow (based on costs at the time this

was written). Even though the costs of new construction are higher than in earlier periods, the cost of construction and equipping new buildings for the dairy herd may not exceed the annual gross income from the dairy enterprise.[1]

With newer methods of storing hay and silage, pole frame construction, special milking rooms, and many other features which may



(a) (b) (c) (d)

FIG. 27.5 (a) A pole-frame building during course of construction (b) The building after it was enclosed for hay storage (c) The building being filled with chopped hay. (d) Self-feeding the chopped hay The feed rack is pulled forward as needed by a tractor.

result in savings in construction and equipment, the investment may be kept low enough to permit a good return on the investment. The high cost of buildings, however, emphasizes the constant need for intelligent methods of management in every phase of the care of the dairy herd. Many of these methods have been explained in the earlier chapters of this book. Some of the features of good herd management which have a direct bearing on building cost per cow are (1) keeping a high proportion of the herd in producing condition,

[1] Van Arsdall, R. N., and Cleaver, Thayer. New Investments in Dairy Structures Ill Farm Econ, No. 201, 1298–1303, 1952

(2) retaining only as many head of young stock as needed for herd replacements, and (3) keeping as many producing cows as the buildings will accommodate. Since a high-producing herd makes better returns than does a low-producing one, it is obvious that a dairy farmer who keeps high producing cows is in an advantageous position with respect to paying for a barn from the herd income.

Planning an attractive barn. Attractive, convenient, and comfortable buildings help to make dairy farming a pleasurable occupation. Such buildings also add greatly to the value of the farm property.

Buildings which make possible savings in the number of hours required to do the various jobs involved in caring for the dairy herd are a distinct asset in times of high labor costs. Convenience and comfort at all seasons also are factors in making possible the obtaining and keeping of a high grade of hired labor, as well as being an inducement to the young folks in the farm family to take more than a casual interest in the farm program.

The sale value of an income producing property is greatly influenced by having buildings and equipment in good operating condition and well suited for doing the job efficiently. The durability of the property and the evidence it gives of the costs of repair and maintenance also are influencing factors. An unsightly, ramshackle barn which is in good enough condition to pass inspection today but which indicates a short life with high upkeep costs is not likely to have as good sales appeal as an attractive, substantial barn.

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NOTE A number of selected government publications on farm construction are for sale by the Superintendent of Documents U S Government Printing Office, Washington 25 D C

REVIEW

1 Name the six principal functions of a dairy barn

2 Why must dairy barns in the northern states be kept comfortable in the winter?

3 What two principal construction features provide winter comfort for the cows and the workers?

4 Why is insulation needed in barns? How is it installed?

5 Give and explain four reasons for ventilating dairy barns

6 What is meant by (1) a gravity system of ventilation (2) mechanical ventilation? Mention the essential features of each system

7 List the advantages and disadvantages of (1) pen barns (2) stanchion barns

8 How can the work program be planned to provide a minimum amount of labor in (1) feeding (2) disposing of manure and (3) supplying water?

9 List six barn construction features which aid in the production of high quality milk, and discuss each of these

10 Discuss the items which should be considered in locating the dairy barn

11 What is the annual cost of buildings for a dairy cow? How is this cost determined? What can be done to keep this cost reasonable?

12 Why should the dairy barn be attractive and comfortable?

28

Insuring a Sound Basis for the Future

A person who engages in dairy farming usually does so in the belief that this type of farming will assure him a satisfactory income over a period of many years provided he operates the farm in a competent manner Reasons for believing that dairy farming is likely to have a good future have already been given (Chapter 1)

Suitable returns from any form of productive enterprise are dependent, of course upon a vigorous market that is one which will absorb the product at a price which furnishes some profit to the producer In times of national emergency governmental purchases of farm products the establishment of price floors and ceilings, payments for acreage adjustments and other practices have been instituted for the purpose of supporting prices of farm products When such controls lead to the accumulation of products in amounts greatly in excess of normal consumption they must ultimately collapse Farmers cannot expect to operate profitably under a system which supplies far more products than are consumed In most cases a food or crop production enterprise must have a sound economic basis within itself, that is, it must produce products which will readily find a market at prices which return a fair margin of profit to the producer

The demand and prices for dairy products are affected by changes in (1) the level of industrial employment (2) world markets, and (3) preferences of consumers for certain food products How can a dairy farmer plan his farm operations so that he will realize a reasonable return for his labor and capital investment even though price and other economic conditions fluctuate from time to time? A few of the more important principles which a dairy farmer may employ as guides are discussed herewith

Obtain a production unit of economical size A dairy farm may be too small or too large for successful operation The capital investment in land buildings, livestock, and equipment, and the amount

of labor for the production of each 100 pounds of milk must be adjusted so that a reasonable return can be obtained Occasionally, economy of production can be improved by making adjustments in the factors of production, such as (1) increasing the number of cows kept, (2) substituting mechanical equipment for hand labor, or (3) purchasing or renting additional land

Fig 28 1 Sheep are large users of roughage and may be a valuable adjunct to a dairy enterprise

Provide a diversity of enterprises. Many dairy farmers find it advantageous to engage in one or more enterprises in addition to the keeping of dairy cattle This may be some other livestock enterprise, such as poultry, sheep, or swine, or the raising of some cash crop such as potatoes, corn, or small grain These other enterprises often make for a more efficient use of labor and equipment than concentrating all of the farm resources on only the dairy enterprise

Maintain high level of productivity. Given highly productive land, the cost of producing 75 bushels of corn to the acre is but little more than the cost of growing 50 bushels to the acre Likewise a cow with an inherently high productive *capacity can produce 12,000* pounds of milk annually at only slightly greater cost than that for a

yield of 8000 pounds a year In both cases there is likely to be a much greater net return from the higher level of production In periods of low market prices, the returns from low-producing units may be insufficient to meet fixed costs of production One of the cardinal production principles which a dairy farmer must ever keep in view is the maintenance *of all factors of production in such condition* that they are capable of large outputs

Produce a high-quality product With the increasing emphasis being placed upon safeguards to public health and upon furnishing excellent dietary values in the production, processing and distribution of foods, no phase of the food industry reflects this trend more clearly than the dairy industry For the sake of better immediate returns to the individual producer, as well as for the future benefit of the entire dairy industry, it is imperative that each dairy farmer strive to produce a high-quality product every day in the year For those whose income comes chiefly from the sale of milk, the production of milk of highest grade, such as grade A, has usually brought much larger returns than the production of milk of lower grades

Make marketing a part of the farm operations Too often dairy farmers accept no responsibility for the marketing of their milk In many cases where dairy farmers have established cooperative marketing agencies, returns have been much more satisfactory than when they have depended only on general markets A constant study of the market situation with an attempt to improve any phase of his marketing program is fully as important a feature of good dairy farm management as keeping a careful watch on the rations being fed

Help to advertise dairy products In recent years there has been a rapid increase in the replacement of butter and other dairy foods by substitute products The need for advertising dairy products is now greater than ever before, unless the public is made conscious of the high nutritive values of these products and is persuaded to buy them, dairy farming is likely to provide only a small income for the farm operator

Most industries have large advertising budgets and spend a considerable sum in advertising for every $100 worth of sales The manufacturer of automobiles, in order to reach prospective customers, does not depend upon mere public display of the automobiles of his make in daily use on streets and highways but employs numerous advertising mediums, such as attractive printed matter, radio and television programs, and direct salesman contacts Each year several

million wives begin housekeeping, and each year several million potential customers of the dairy industry are born Young mothers and housekeepers, as well as older ones, need constant reminders of the exceptional nutritive qualities of dairy products

Dairy farmers must take an aggressive part in the advertising and marketing of products they offer for sale No doubt this can best

Fig 28.2 The unexcelled nutritive value of milk and its products is the best assurance of a sound future for the dairy industry (Agricultural Photo Library)

be done by contributing through their marketing organizations specified sums for each hundredweight of milk marketed or a percentage of their receipts

Support vigorous research programs Most large industries spend large sums of money for research in an effort to make constant improvement in the efficiency, appearance, or economy of their products Agriculture has fallen far behind industry in expenditures for research In the past a large part of the money for agricultural research has come from the national and state treasuries It is imperative that dairy farmers not only seek larger appropriations from these sources but also that they contribute from their own dairy receipts additional funds for the support of research at public institutions

Conserve the soil. Dairy farmers are well situated to adopt grassland farming systems and cultural practices which keep soil losses at a minimum Good systems of soil management make possible the operation of a dairy farm for an entire lifetime without decline in its productive power One of the greatest services which a dairy farmer can render is to conduct his farming operations in such a manner that he will pass on to the next generation a farm fully as fertile and perhaps even more productive than it was when he began to operate it Only when the fertility of our soils is considered as a priceless heritage and is properly conserved, can there be assurance of an adequate and economical food supply for future generations

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REVIEW

1 When planning his farm operations what factors must a dairy farmer keep in mind with respect to the possibilities of a profitable market for his products?

2 Explain how the following factors aid in insuring a sound basis for profitable dairy farm operation (*a*) a production unit of economical size (*b*) a diversity of enterprises (*c*) a high level of productivity (*d*) a high-quality product (*e*) attention to marketing (*f*) advertising farm products (*g*) supporting research programs and (*h*) conserving the soil

29

Dairy Farming Offers Good Opportunities for Young People

Young people who are considering the possibilities of various vocations may well study the opportunities which are afforded by dairy farming. It is a natural and wise precautionary measure before spending several years in school in preparation for a particular field of work, or before investing a considerable amount of capital, to give full consideration to the returns to be expected. Does dairy farming offer sufficient opportunities and rewards to attract ambitious and intelligent young men and women? Is a dairy enterprise likely to prove a profitable investment?

The answer to both of these questions is yes. Dairy farming offers a challenge to individuals having keen intellects and thorough school training as well as to those who have acquired their skill and knowledge through farm experience. The financial returns from invested capital are comparable with the returns from other types of farming and from other kinds of enterprises under similar levels of managerial ability. There is a wide diversity in size of farms, productive capacity of the soil, prices at different markets, and ability of operators, so that returns differ widely from one farm to another just as they do in any type of business venture. The dairy farm operator who is above average in ability has the opportunity of earning more than an average income. (See Chapter 19.)

Financial security afforded. The amount of the annual income is a factor of primary interest in any business or farming enterprise, but one should also give attention to the relative security of the investment and whether or not there is assurance of a continued and regular income. Dairy farming over a period of many years has been a relatively safe form of enterprise. Revenues have been regular and continuous. In periods of severe price depressions, dairy farmers like other farmers and merchants, sell their products for less than normal prices, but as a rule dairy farmers do not have on hand large inventories of supplies purchased at high cost and on which they must suffer a loss. The demand for milk and other dairy prod-

ucts fluctuates with industrial employment and wages, but milk is so highly regarded as a needed constituent of the diet that it finds a ready sale even in times of reduced industrial activity

The sale of milk or cream throughout the year and the receipt of payments at monthly or at less than monthly intervals is of great aid in financing the operation of the dairy farm There are many current farm expenses, such as cost of hired labor, feed, fuel, and electricity, as well as family living expenses which must be regularly met The maintenance of a constant cash income to meet irreducible cash outlays is an outstanding advantage over other types of farming in which the crops or livestock are sold seasonally or once a year

Dairy farming is to a considerable extent a family type of enterprise, and hired laborers for the most part are not organized Dairy farm operators fortunately do not often suffer severe inconvenience and are rarely compelled to cease activities because of labor disputes

A wholesome environment provided The income which can be expressed in monetary terms, regardless of whether it is cash income or the value of products consumed on the farm is by no means the only reward to those engaged in dairy farming There are many other rewards and opportunities, the value of which cannot be calculated in dollars

Dairy farming, in common with most other types of farming, affords opportunity for the development of a wholesome and happy family life The family works as a group in performing many of the jobs concerned with both livestock and crops In most cases dairy farming is a family enterprise The farm home is the central unit which houses the workers and from which the farm activities are planned and directed Farm children, during the years they attend school, help with the milking and care of the dairy herd and assist in other farm tasks, thus contributing to the family income at the same time they are receiving valuable training in a useful vocation

Modern dairy farming, efficiently organized and operated, provides income to support character-building institutions in rural communities The church plays a significant part in the moral and spiritual development of rural children, for farm people, as a whole, are church minded This is a factor of no small consequence in the attainment of happy and contented farm living With improved roads and transportation facilities, churches, schools, recreational centers, and amusements of town and city are open to a high percentage of farm families

Opportunities for leadership. The dairy farmer has a wide diversity of interests. He is concerned with many of the same problems as those which confront the grain farmer or the general livestock farmer. Besides opportunities for participating in the work of farm

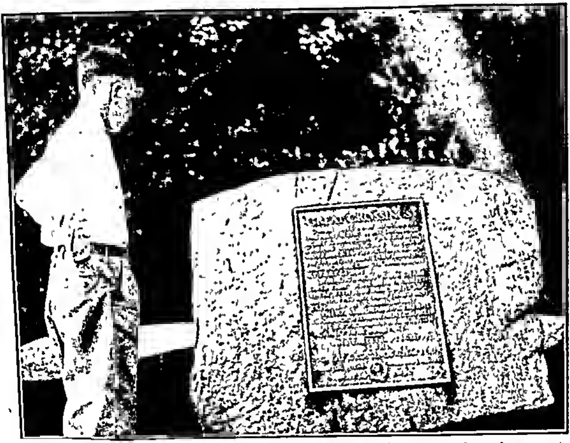

FIG. 29.1. "Great Crossings" confront young men and women when they must face the problems of a life vocation. Fortuoate indeed are the young people of the United States, for in most cases they are not hampered by tradition, caste, laws, or monetary considerations in choosing the vocation which appeals most stroogly to them.

organizations dealing with crops, soil improvement, and other classes of livestock, there are many openings for leadership in the numerous organizations dealing with his own special field of work. Groups such as dairy herd improvement associations, dairy cattle breeders' associations, and milk marketing groups are constantly in need of directors and other officers. The well-trained and capable dairy farmer who takes an active part in the work of such groups can contribute much to community welfare as well as to the advancement of his own interests.

The young folks on dairy farms have special opportunities for training in leadership Participation in calf club projects as a phase of 4-H club work and the exhibition of calves, as well as other farm and home products, help to give them self-reliance and confidence in their abilities and to train them for positions as leaders

Fig 292 Many outstanding dairy herds have been developed as a result of the interest of young people enrolled in club projects or high-school agricultural courses (Photo J C Allen and Son)

Farm background valuable For the person who desires to enter a professional career in agriculture, such as teaching, research, and extension service there is no adequate substitute for the experience and training which a farm raised boy or girl receives in the day today activities connected with farm life Although a college education is in most cases prerequisite to professional work, college training does not supply the know-how and experience which a person obtains in the growing of crops and in the care of farm animals

Saving is encouraged The wide awake and ambitious dairy farmer is constantly confronted with many investment opportunities through improving his production facilities whether these be better cows, better machinery and equipment, better buildings, or improvement in the yields of his crops brought about by new varieties or further increments of lime or other fertilizers The use of capital

in these ways usually brings increased returns and a stimulus for saving a part of the income for still further investments, even though a part of the enlarged income may be spent to bring about a higher standard of living for the family.

The need of saving money for the future, particularly for security from want in old age, appears to many people to be of less and less importance as government establishes more and more aids to individuals in the form of unemployment compensation, disability benefits, old age pensions, and similar provisions. Since all such payments must come from the earnings of the people, chiefly in the form of income and excise taxes, the authors cannot help but view with apprehension and alarm the growing tendency to minimize the importance of thrift and the saving of money by the individual for future need. It appears to them that too much dependence upon government tends to destroy initiative, retard progress, and involves too great a risk of financial catastrophe should a period of widespread unemployment occur. With a constantly increasing proportion of the population employed as workers in industrial pursuits and a smaller proportion engaged in occupations which provide a part of the subsistence, the need for stabilizing influences on our economy becomes more urgent.

Desire for improved methods created. Farming is a mode of life, to be sure, and a most enjoyable one in many respects, but it is also a means of earning a living for the operator and his family. Most of the activities of the dairy farm are such that they create a desire on the part of the enterprising farm operator for better cattle and arouse his interest in selection and breeding programs. He is also anxious to learn of the latest scientific developments which may aid in the production of his crops, particularly with respect to such items as new crop varieties, improved soil treatments, recently discovered insecticides, and better machines and equipment. Dairy farmers eagerly adopt new methods which will help them conduct their farm operations more efficiently.

Initiative stimulated. American farmers, as a whole, have a great deal of initiative, and to this factor may be credited in large measure the great advances they have made in farming methods, the enormous increase in the amount of food produced annually, and their highly favorable financial position. Farmers of America enjoy the opportunity of operating their farms on a business-like basis and using their initiative and independent thinking to their fullest advantage. Unfortunately this is not the case in all countries. Oliver Goldsmith wrote:

Princes and lords may flourish or may fade
A breath can make them as a breath has made
But a bold peasantry—the country s pride
When once destroyed can never be supplied

In Goldsmith's day peasantry was an integral part of the economic system, and such a system still is found in some countries A high proportion of the farmers in those countries have no opportunity to choose a vocation Some inherit small farms and others rent portions of large estates Farm laborers seldom accumulate enough capital to become land owners Both farm operators and laborers continue generation after generation in the same type of farming and in the use of the same methods, largely as a matter of custom and tradition

God forbid that the initiative and progressive spirit of American farmers shall be stifled or destroyed to such an extent that farming in the United States will decline to a form of peasantry with a loss of independent thinking and action Far more destructive of inspiration, pride in their vocation, and individualism would be a system of agriculture, enforced because of continued wasteful farming or a radical change in political control, in which all farm land becomes the property of the state and farmers are merely government-directed laborers who have no share in management and do not profit from their labor other than to receive a wage or daily food America is often spoken of as the land of opportunity, and too often opportunity conveys only the meaning of chances to accumulate money But there is far more to the meaning of opportunity in America than the mere reaping of financial rewards This has been well expressed in the following quotation from the "National Hymn of Thanksgiving"

Not alone for mighty empire stretching far o er land and sea
Not alone for bounteous harvests lift we up our hearts to Thee
Standing in the living present memory and hope between
Lord we would with deep thanksgiving praise Thee most for things unseen

Not for battleship and fortress not for conquest of the sword
But for conquest of the spirit give we thanks to Thee O Lord
For the priceless gift of freedom for the home the church the school
For the open door to manhood in a land the people rule[1]

—William Pierson Merrill

The opportunity which is described in this hymn, that of developing character and capability in a free, democratic land where homes,

[1] Quoted by permission

churches, and schools are its proudest possessions, is the richest heritage of America

Can young dairy farmers retain their heritage? Dairy farmers can play an important role in the continued freedom of church and

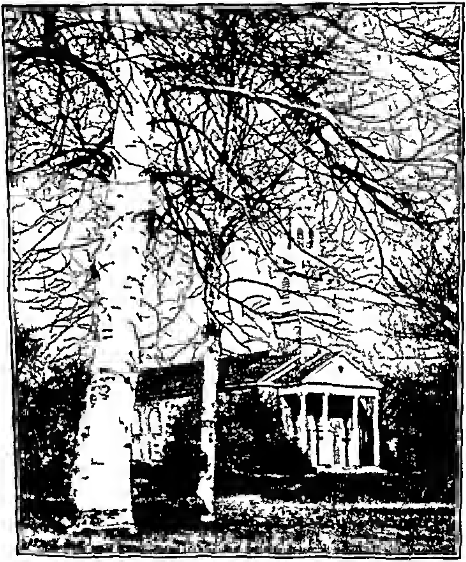

Fig 29.3 The rural church is one of the most effective means open to young people for the development of strong moral ethical and religious values as well as affording opportunities for splendid social activities (Agricultural Photo Library)

school, in the maintenance of franchise, and in the establishment of homes which will provide the maximum in happiness and contentment But first of all, they must contribute to human welfare by providing needed foods which are safe, wholesome, and economically produced Further, they must conduct their operations in such a manner that the productivity of the land they farm will be main-

tained at high levels And then, too, not only young men and women who engage in dairy farming but every American should develop the concept that our greatest natural resource the soil, belongs to the people of the entire country and has been placed as a sacred trust in the hands of farmers who serve as custodians rather than as the sole arbiters of its disposition Many millions of acres of farm land have been ruined beyond redemption for cropping purposes and hundreds of millions of acres are being severely damaged by continuous heavy cropping and erosion Unless destructive methods of farming cease and in their stead are instituted systems which will maintain soil productivity at high levels an enlarging population cannot hope for an abundant food supply security from foreign aggression and continued enjoyment of the blessings of home church, and school Surely dairy farmers are in a highly favored position since the type of farming they pursue is in principle one which helps to ensure long continued possession of their priceless heritage The greatest incentive and the greatest reward of the young American dairy farmer today is *opportunity*

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REVIEW

1 Discuss the opportunities dairy farming affords to young people for each of the following (*a*) financial security (*b*) a wholesome environment (*c*) leadership (*d*) saving money (*e*) creating a desire for improved methods (*f*) stimulation of initiative and (*g*) retaining their heritage

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